JULY, 1951

PETROLEUM REFINER

SPECIALIZED FOR REFINING, NATURAL GASOLINE AND PETROCHEMICAL ENGINEERING, OPERATION AND MANAGEMENT

Hortonspheres are the most modern answer to the problem of storing volatile hydrocarbons under pressure. Their spherical shape, their wide range of design pressures and their efficient use of vital materials, all combine to form a positive, economical means of storing the more volatile grades of natural gasoline, butanes, butane-propane mixtures, and other refinery stocks. Bulletin F contains detailed information about Hortonspheres. If you handle volatile hydrocarbons, write our nearest office for your copy. See how efficiently and economically you can solve your volatile liquid storage problems.

Beckman pioneers another instrumentation advancement . . .

SINGLE BEAM *direct Transmittancy recording* *with* BECKMAN *infrared spectrophotometers*

NEW SINGLE BEAM SYSTEM IS SIMPLE, ACCURATE, RELIABLE

The Beckman Single Beam Direct Transmittancy Recorder employs the memory standardization principle, using reliable electronic circuits instead of complicated mechanical-optical arrangements. It successfully combines the highest accuracy with the utmost in reliability and convenience. A standardizing run is made on the empty or solvent-filled absorption cell. During this run the signal from the photoreceiver is automatically maintained constant, and the resulting slit width vs. wavelength function is "memorized" on a wire recorder. The sample is then placed in the same cell, and information played back from the wire recorder automatically controls the wavelength and slit drive motors to reproduce precisely the conditions which produced the constant 100% reference level. Any absorption resulting from the sample is accurately and automatically recorded directly in transmittancy. On repeat runs, the same reference wire is used, eliminating repetition of standardizing measurements.

Single beam transmittancy recording retains the excellent resolution, low stray light, high stability and drift freedom, and the wavelength accuracy of the well-known Beckman Spectrophotometers. Other advantages are summarized at the right.

THREE UNEXCELLED INSTRUMENTS FOR ANY REQUIREMENT

Beckman Single Beam Direct Transmittancy Recording is available either (1) as an accessory unit for direct installation on any Beckman IR-2 Spectrophotometer, or (2) with the IR-2 as a complete instrument, or (3) in the new unsurpassed Beckman IR-3 Spectrophotometer—the most versatile, most accurate, most complete—and by all standards, the *finest* spectrophotometer money can buy.* For further information on these instruments write . . .

Beckman Instruments, Inc., South Pasadena 23, California.

BECKMAN INSTRUMENTS
control modern industries

Factory Service Branches: NEW YORK · CHICAGO · LOS ANGELES

**As in all Beckman Instruments, your money buys more value than in any similar product.*

IMPORTANT ADVANTAGES of the Beckman Transmittancy Recorder

- **GREATER CONVENIENCE:** The single-beam principle eliminates troublesome, time-wasting cell- and beam-matching problems.
- **GREATER VERSATILITY:** Greater versatility and simplicity and lower costs are assured, since special cells and attachments need not be duplicated for use in a reference beam.
- **GREATER ACCURACY:** The single-beam principle eliminates problems of making a beam attenuator achromatic, linear and free of vignetting effects.
- **MINIMUM STRAY LIGHT:** Only these single beam instruments use a filter-type beam chopper, reducing stray light effects to a minimum (less than 2% at 15 microns with the IR-2).
- **MINIMUM SCANNING TIME:** Optimum recording efficiency is achieved because each spectral slit width is traversed in a time proportional to the response period of the recording system. Any other scanning rate loses either resolution, time or accuracy.
- **MAXIMUM RESOLUTION:** Slit width control has the advantage that the instrument is always working at maximum resolution for the chosen amplification and scanning speed.
- **FLEXIBILITY OF CONTROL:** Operating speed, resolution and chart scales can be easily varied over wide ranges. A single control adjusts scanning time per spectral slit width from 1 second to 128 seconds by factors of 2. The wavelength motor speed is electronically controlled with no gear shifting needed to change scanning speed.

In addition to recording linearly in wavelength, a unique electronic system enables recordings to be made linearly in other functions such as frequency or log wavelength.

✻ Beckman Instruments include: pH Meters and Electrodes — Spectrophotometers — Radioactivity Meters — Special Instruments

PETROLEUM REFINER

Specialized for Refining, Natural Gasoline and Petrochemical Engineering, Operation and Management

R. L. DUDLEY, President — A. L. BURNS, General Manager

VOLUME 30, NO. 7 — JULY, 1951

Contents

- **The Middle of the Barrel Comes of Age** 71
  There is an increasing need to shift oil refining operations from emphasis on gasoline production to increase the yield of middle distillates for our domestic market.
  A. L. Nickerson
- **Aromatics Recovery by Solvent Refining B, B'-Oxydipropionitrile as a Selective Solvent** 97
  The nitriles exhibit high selectivity for aromatic hydrocarbons over paraffins and form the basis for effective separation by hydrocarbon type.
  E. C. Medcalf, A. G. Hill, G. N. Vriens
- **Nomogram for the Solution of Anchor Bolt Problems** 101
  Graphical methods facilitate the design of bolting for tall towers and stacks.
  Abraham I. Gartner
- **Visbreaking of a High-Vacuum Petroleum Residuum** 107
  A distillation process operating at pressures of 0.1 mm Hg to 0.8 mm Hg is being used to recover clean low carbon residue gasoil from topped crude, the residue being thermally cracked in a new type radiant heater.
  J. G. Allen, D. M. Little, P. M. Waddill
- **How To Do It** 115
- **Metallizing to Prolong Life of Equipment** 118
  Metallizing, properly applied, offers many opportunities for savings in maintenance time and expense.
  Joe E. Young, Jr.
- **Operations Safety** 121
  Arc burns, resulting from exposure of the unprotected eyes to the glare of a welding arc, are both painful and needless.
  W. A. Sallender
- **New Ethylene Process Uses Naphtha Pyrolosis** 122
  Plant employs temperatures ranging from over 1700° F. down to —220° F.
  Kellogg-Ethylene
- **New Thermocouple-Type Gas Combustible Analyser Expands Field of Application** 124
  Convenient and accurate methods of measurement for combustibility is of real value to operating groups. This new instrument is said to incorporate these qualities.
  F. Taylor, Jr.
- **Benzene from Petroleum—How and How Much** 127
  New processes offer means for producing the aromatics we need for our national defense program.
  Gustav Egloff
- **Montreal East Refinery Includes Unique Cat Cracker** 130
  The operation of this new plant is subjecting several innovations in cracking unit design to the tests of commercial application.
- **A Direct Method for Solving Flash Equilibrium Calculations** ..132
  A new approach to the old old problem yields first-trial solutions that in most cases are well within the accuracy of the equilibrium data.
  P. M. Reilly
- **Supports for Vertical Pressure Vessels, Part I** 137
  Stresses occasioned in support structures through variations in vessel operating pressures or temperatures are often large and should be considered in design computations and layouts.
  F. E. Wolosewick
- **Improved Methods for the Particle Size Analysis of Fluid Cracking Catalysts, Part II** 141
  This test method is said to be "The best method to date for determining accurately the particle size analysis of our fluid type petroleum catalysts."
  F. Emerson Ivey
- **Refinery Is Advanced Example of Combination Oil Processing** 146
  Alberta's first catalytic cracking unit is in operation at new British-American plant.
- **Refrigeration in the Refining Industry, Part III** 147
  Problems encountered in the operation of refrigeration apparatus in processing plants.
  Tyler G. Hicks
- **King-Size Welding** 150
  Picture story of how 5½-inch plate is handled.
- **A Guide to Economic Line Sizing for Plant Piping** 151
  Consideration of each process plant flow system with regard to its part in the process, control characteristics, flexibility, and economics, is necessary in order to correctly size the pipe lines and establish pump heads and characteristics.
  H. B. Manley

DEPARTMENTS

The Look Box 67
Refinery and Other Plant Construction 73
How to Do It 115
Refiner Authors and Other Personalities 154
The Month in the Industry 159
Oil Man's Calendar 161
Science and Technology Abstracts 173
Compiled by Dr. E. H. Leslie and Dr. H. B. Coats
Digest of United States Patents Pertaining to Petroleum 185
Compiled by Dr. Heinz Heinemann
Book Reviews 204
New Equipment, Manufacturers Literature 207
About Equipment and Service Supplier 224
Index to Advertisers 234

RAY L. DUDLEY, *Publisher*
L. S. DANIELS, *Editor*
SILAS B. RAGSDALE, *Managing Editor*
L. J. LOGAN, *Economics Editor*
ALICE L. GIVEN, *Editorial Assistant*
DR. E. H. LESLIE, DR. H. B. COATS AND DR. HEINZ HEINEMANN
Department Editors
ROBERT E. SPANN, *Eastern Editor*
MARY E. ZUBER, *Librarian*

THE GULF PUBLISHING COMPANY
Box 2608, Houston (1), Texas

Specialized Oil Publications of
PETROLEUM REFINER and The REFINERY CATALOG
for the refining-natural gasoline industry

WORLD OIL (formerly The Oil Weekly)
and The COMPOSITE CATALOG
for the drilling-producing-pipe line industry

TOM W. NELSON, *Advertising Manager*
ROGER MOTHERAL, *Eastern Adv. Mgr.*

Advertising Representatives

NELSON BIGELOW
250 Park Ave.
New York 17, N. Y.

BILL WESTFALL
1010 Euclid Ave.
Cleveland 15, Ohio

H. G. FITZPATRICK
MARTIN HALLORAN
332 S. Michigan Ave.
Chicago 4, Ill.

CHARLES WYATT
DOUG CRAIG
3301 Buffalo Drive
Houston 6, Texas

J. W. CURTS
W. W. Wilson Bldg.
Huntington Park, Calif.

BILL ATCHESON
Hunt Bldg.
Tulsa 3, Okla.

Circulation Department
R. M. DE SOMBRE, *Manager*
Box 2608, Houston, Texas

Single copies 50 cents (except special issues) for U. S. and Canada; $1 for all other countries. Subscription rates—U. S. and Canada $2 a year; Latin America $8 a year; overseas $10 a year. PETROLEUM REFINER, published every month, entered as second class matter June 16, 1923, at the post office at Houston, Texas, under act March 3, 1879. Advertising rates on application.

Copyright 1951 by Gulf Publishing Company.

Petroleum Refiner is indexed by Industrial Arts Index and by Engineering Index, Inc.

Use the C_Q Method—

Evaluate All The Quality Factors
IN SELECTING CONTROL VALVES

"Quality" is only a word—which has no real number or scale; but, by definition, it implies comparison and by common usage it connotes high value.

The C_Q (Quality Coefficient) method sets a standard — which is necessarily also intangible but one which could, if you wished, be given an arbitrary numerical expression.

Our standard of design and manufacture is to build a control valve which, in the light of our extensive knowledge and experience, will live up to our definition of quality, i. e.:

"A high quality product provides accurate performance over a long period with a minimum of maintenance and operation delays."

Your standard in selecting control valves is undoubtedly very similar, based on your own experience.

We suggest your using the C_Q method in comparing control valves. Set a standard; evaluate *all* the quality factors in the valves considered. (As a reminder, a list of some of these is printed here.) The sum of all quality factors of a valve is its C_Q (Quality Coefficient). Then when you compare price, consider that the invoice figure is only the first cost — the real cost might be expressed

$$\text{Real Cost} = \frac{\text{Price}}{C_Q}$$

for you will agree that for the same investment, the higher the quality the lower the actual over-all cost.

Compare Masoneilan Control Valves with *any* others — use the C_Q Method.

Check For These Diaphragm Motor Quality Factors

Performance Factor

Effective Diaphragm Area
Stroke Length
Response to Air Pressure Changes
Stroke vs. Air Pressure Relationship
Guide Design for Minimum Friction

Mechanical Construction Factor

Diaphragm Case Air Pressure Rating
Diaphragm Case to Yoke Fastening
Rigidity and Strength of Yoke
Yoke Connection to Body Assembly
Strength of Spring Stem and Diaphragm Button Assembly
Size of Springs vs. Effective Area and Stroke of Motor
Diaphragm Design for Reproducible Stroke
Motor Guiding for Friction Free Operation

Convenience Factor

Provision for Mounting Instruments and/or Accessories
Adaptability to Air-to-Close or Air-to-Open Action
Provision for Various Types of Handwheels
Selection of Stroke and Spring Range

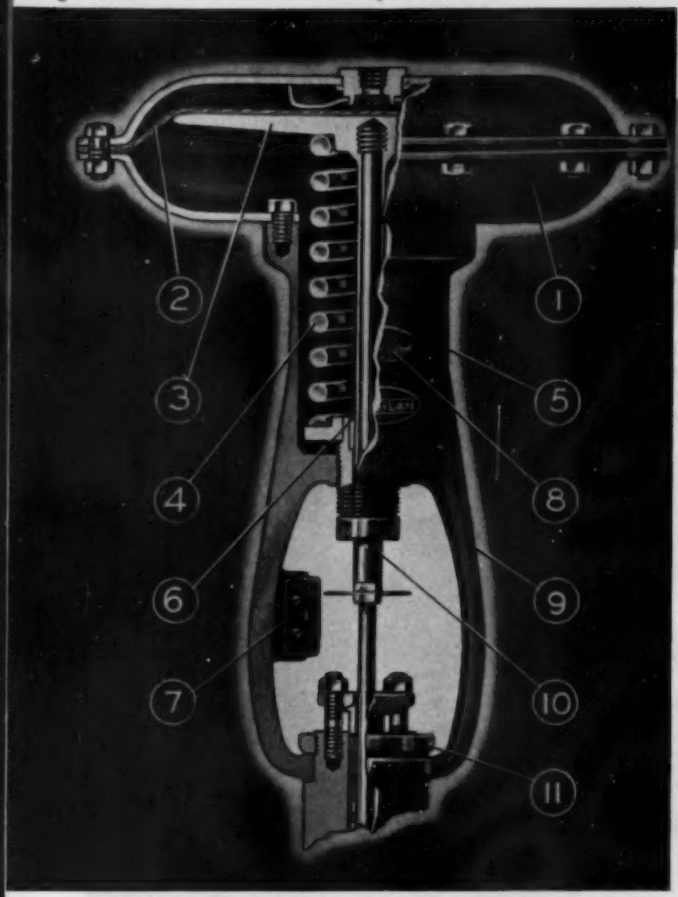
Maintenance Factor

Accessibility of Valve Stuffing Box
Convenience of Spring Adjustment

Appearance Factor

Low Over-all Height
Smooth External Contours
Compactness
Serial Plate Information
Travel Indicator Design
Ability to Withstand Rough Handling
Strength of Stem and Stem Connections
Protection of Spring and Diaphragm

SEE OUR EXHIBIT IN BOOTHS 214-216 AT THE SIXTH NATIONAL INSTRUMENT EXHIBIT.



For Example Consider the Diaphragm Motor of Masoneilan 10,000 Series Control Valves

1. **Steel Diaphragm Case** for high mechanical strength, lightness, high safety factor in case of severe over-pressuring. Parkerized inside and out for corrosion resistance. ¼" or ½" air connection fitting welded inside case for better appearance. Initial stop inside case establishes correct stroke with respect to diaphragm position. Through bolted construction for ease of disassembly — avoids moisture-collecting pockets which cause rusting. Permits use of flat stock diaphragms in emergency. Adapted to case-mounted handwheels. Provides for reverse-acting motors for valves with non-reversible plugs.

2. **Preformed Diaphragm** of rubber or neoprene with fabric insert — designed to provide maximum practical effective area throughout stroke. Provides frictionless self-aligning upper guide. Beaded edge adds insurance against leakage.

3. **Steel Diaphragm Button** — compact and strong — welded to spring stem, preventing possibility of disengagement in the event of excess line vibration.

4. **Heavy Springs** for low stress — prevents breakage and permanent set. Calibrated for 3-15 or 6-30 psi ranges. Japanned for corrosion resistance. Exterior adjustment for ease of setting spring initial — has ball thrust bearing on larger size valves.

5. **Cast Iron Yoke and Spring Barrel** have heavy cross-sections for rigidity and mechanical strength; will not deform in rough handling, causing misalignment. Inherently corrosion resistant. Inclosed spring barrel protects springs. Unusually large opening in yoke provides ease of access to stuffing box and positioner linkage — makes stroke scale easily readable. Yoke designed for side mounted handwheels.

6. **Oilite Bronze Lower Guide** together with self-aligning frictionless upper guide in diaphragm insures alignment, minimum friction.

7. **Stroke Scale** graduated in ¼" of actual travel. Rated stroke marked on plate. Indicator index always at same position on spring stem — aids in stem adjustment on assembly.

8. **Mounting Pads** — front and rear, provide for mounting controller, positioner and/or air set.

9. **Serial Plate** has *full* valve specifications — materials, rating, spring range, direction of travel — even an etched picture of type and seating direction of plug.

10. **Large Diameter Spring Stems** for strength; direct threaded connection to valve stem without use of adapters; plus Keylock on sizes 3" up.

11. **Motor to Bonnet Connection** by means of heavy, large diameter, forged steel drive nut, for strength and true alignment.

THE MASONEILAN 10,000 SERIES CONTROL VALVE IS

A High C_Q Product

MASON-NEILAN REGULATOR CO.

1182 Adams Street, Boston 24, Mass., U. S. A.

Sales Offices or Distributors in the Following Cities

New York • Syracuse • Chicago • St. Louis • Tulsa
Philadelphia • Houston • Pittsburgh • Atlanta • Cleveland
Cincinnati • Detroit • San Francisco • Salt Lake City • El Paso
Boise • Albuquerque • Charlotte, N.C. • Los Angeles
Denver • Appleton, Wisconsin • Corpus Christi • New Orleans
Mason-Neilan Regulator Co., Ltd., Montreal and Toronto

YOU CANNOT INSURE FULL C_V WITHOUT A HIGH C_Q

SAM HOUSTON COLISEUM, HOUSTON, TEXAS, SEPTEMBER 10-14, 1951

Which one of 23 high temperature tube steels do you need? Ask the experts!

AMONG the 23 high temperature tube steels produced by Timken,® there is *one* and only *one* which can solve your heat, pressure, corrosion, and oxidation problems and give you the *best* life/cost ratio, too. And metallurgists of the Timken Company can help you pick it.

These metallurgists are recognized authorities in high temperature steels—have 21 years of experience and research behind them. With 23 analyses to choose from they can recommend the one best tube for your job. And whichever tube you use, you can be sure of uniform quality; Timken closely controls quality from melt shop through final inspection.

Let Timken's "RSQ"—Research, Supply, Quality—solve your high temperature tube problems. Ask the experts! The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

This month Timken reports on:

SICROMO 2½

Suitable for applications in which corrosion resistance is a major consideration, but where conditions do not warrant use of higher-price 4-6 Cr.-Mo. steel. Stability, strength, and oxidation resistance compare favorably with 4-6 Cr.-Mo. Recommended for cracking furnace tubes, heat exchangers, superheater tubes, vapor and hot oil lines.

ONE OF 23 TIMKEN HIGH TEMPERATURE STEELS

Carbon	Sicromo 2	Sicromo 55	16-13-3*
Carbon-Mo.	Sicromo 2½	Sicromo 5MS	25-20*
DM-2	2¼% Cr.-1% Mo.	Sicromo 7	25-12*
Silmo	Sicromo 5	Sicromo 9M	35-15*
DM	4-6% Cr.-Mo.	18-8 Stainless	16-25-6*
2% Cr.-Mo.	4-6% Cr.-Mo.-Ti.	18-8 Cb	

**Available as seamless tubing on an experimental basis only.*

Photo shows metallurgist at Timken determining the lattice structural characteristics of an alloy with X-ray diffraction equipment. Research like this is a big reason for Timken's leadership in high temperature steels.

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

Specialists in alloy steel—including hot rolled and cold finished alloy steel bars—a complete range of stainless, graphitic and standard tool analyses—and alloy and stainless seamless steel tubing

It's easier to maintain ARMSTRONG TRAPS

THEY SELDOM NEED ATTENTION

GOOD preventive maintenance of course calls for periodic steam trap inspection. To look inside an Armstrong trap you simply remove the cap and lift out the entire mechanism, which is connected to it. The body full of boiling water remains in the line and need not be handled.

Only rarely does inspection reveal the need for cleaning or repairing an Armstrong trap. The swirling action of the condensate during discharge continuously scrubs the trap clean. The hardened chrome steel valve and seat stay steam-tight for a long, long time without attention. There is no wire drawing. The leverage system is almost completely friction-free, will operate hundreds of thousands of times without wearing out.

For trouble-free trap performance there is nothing to compare with an Armstrong. Your local Armstrong representative can help you select the right size traps for your requirements. Call him.

ARMSTRONG MACHINE WORKS
852 Maple Street • Three Rivers, Michigan

Armstrong traps on low pressure heating systems require far less maintenance than previous traps...*John Deere Harvester Works, East Moline, Illinois.*

"4 to 5 years service without replacement parts is average on traps draining driers. Some traps in service with no parts for 7 or 8 years—and one for 15 years!"—*Weymouth Art Leather Co., South Braintree, Massachusetts.*

THE ARMSTRONG SERVICE GUIDE explains trap maintenance and repair, contains useful trouble shooting tips. Send for your free copy.

SEE OUR CATALOG IN SWEET'S or ODE

ARMSTRONG STEAM TRAPS

Here's SECURITY AGAINST OVERPRESSURE

Put BS&B SAFETY HEADS to work in your plant and you can forget the danger of overpressure. Here's why:

A SAFETY HEAD is simply two flanges with a rupture disc between. It's the disc that does the job . . . an engineered "weak spot" in your pressure system that bursts before your vessels do. It gives instant, pipe-size relief, and the hazard is over.

There's a SAFETY HEAD for your pressure problems . . . with or without safety valves, for corrosive viscous or super-heated materials. Put the question to our SAFETY HEAD engineers. They'll be glad to serve you. Write or wire today!

BLACK, SIVALLS & BRYSON, INC.
Adv. Dept. Rm. 28F 7502 East 12th Street
Kansas City 3, Missouri

SAFETY HEADS
for
Positive Pressure Protection

LEFT: Catalyst Lift Air blower in foreground supplies air at 13,320 cfm, 4.25 psig to raise regenerated catalyst to reactor. Kiln Combustion Air blower is seen at the right.

BELOW: Carbon is burned off the catalyst while air is supplied at 34,400 cfm, 3.5 psig by this Kiln Combustion Air centrifugal blower.

ALLIS-CHALMERS Centrifugal Blowers

Help New Cracking Methods

AS CRACKING METHODS IMPROVE, more centrifugal blowers are being employed. The Allis-Chalmers single stage blowers seen here are essential to the three new Thermofor Catalytic Cracking units installed by the Magnolia Petroleum Co. at Beaumont, Texas.

Placed "on stream" last Fall, a total of six turbine-driven A-C blowers provide Kiln Combustion and Catalyst Lift Air in the Blower Room of the new catalytic structure.

The high efficiency impellers are of special totally enclosed, backward flow design. This covered design makes the impellers independent of tolerance variations; the backward flow design gives good pressure, volume and horsepower characteristics.

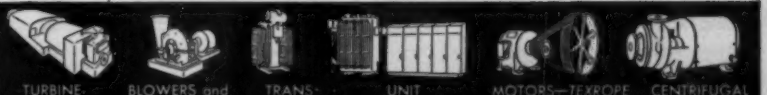
High strength and long life is assured by all welded, alloy steel impeller construction and pressure lubricated sleeve and thrust bearings. Cast iron casing increases rigidity and decreases noise level.

For this kind of specialized design . . . or for standard high quality, thoroughly tested air and gas handling equipment . . . call your nearest A-C office or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3447

ALLIS-CHALMERS

Texrope is an Allis-Chalmers trademark.

Power, Electrical, Processing Equipment for Petroleum Industry



Five Ways to Measure the REAL ECONOMY of Process Pumps

1. **SAFETY**—With I-R refinery pumps, there's no possibility of hazardous leakage at any point. The extra-strong casing, with single ring joint, is easily kept tight. Ample cooling, pressure breakdown and effective sealing minimize stuffing-box seepage. All pumps may be furnished with the Cameron Shaft Seal.

2. **DEPENDABILITY**—To assure maximum continuity of service, these pumps are designed and constructed with materials to withstand the most severe service conditions. Heavy shaft, mechanically and hydraulically balanced impellers, and water-cooled, oil-lubricated bearings permit trouble-free operation at liquid temperatures up to 800°F.

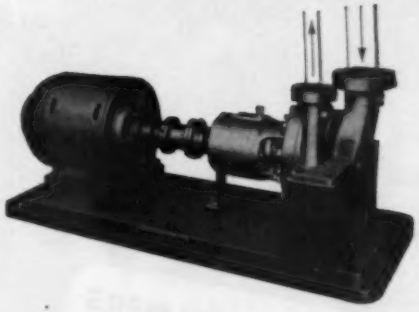
3. **LOW MAINTENANCE**—These pumps are constructed to last longer. Their overall simplicity with all parts easily accessible means less outage for inspection and maintenance. The bearing cradle and rotor can be removed without disturbing piping connections or motor. The single casing joint, with metal-clad ring gasket, is easy to open and re-seal.

4. **SUSTAINED HIGH EFFICIENCY**—I-R process pumps are designed and built to retain their original high efficiency over years of operation. This means lower power cost per gallon moved—over a longer period of time.

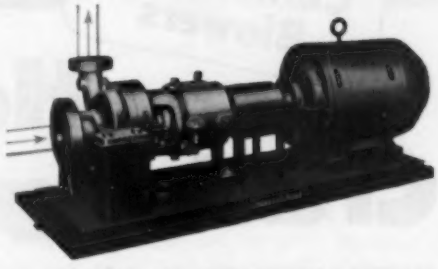
5. **EASY INSTALLATION**—Flexibility of suction and discharge arrangement makes these pumps adaptable to any piping layout. Various types of nozzle flanges are available to meet your exact requirements.

These five factors add up to real, long-range economy. That's why so many refineries and process plants have installed Ingersoll-Rand pumps. Your nearest I-R representative will be glad to give you complete details, and help you with any application problems you may have.

Ingersoll-Rand pumps rate highest on every point



With top (or bottom) suction and discharge.
Capacities—to 1100 gpm.
Pressures—to 275 psi.



With end suction and top discharge.
Capacities—to 3200 gpm.
Pressures—to 275 psi.

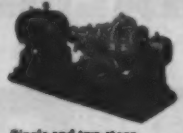
Ingersoll-Rand
Cameron Pump Division
11 Broadway, New York 4, N. Y.

Turbo-Blowers • Condensers • Air & Electric Tools • Hoists
Centrifugal Pumps • Diesels • Compressors
Rock Drills • Gas Engines

571-10

THERE'S AN I-R PUMP FOR EVERY REFINERY NEED

Single-stage, vertically split
Capacities—20 to 3000 gpm.
Pressures—to 300 psi.



Single and two-stage, horizontally split
Capacities—20 to 3500 gpm.
Pressures—to 500 psi.

Multi-stage, with cylindrical "double-case" construction
Capacities—to 2800 gpm.
Pressures—to 3000 psi.

Multi-stage, vertical type
Capacities—10 to 400 gpm.
Pressures—to 1500 psi.

Vertical, turbine-type—1, 2, 3 or more stages
Capacities—60 to 3500 gpm.
Pressures—to 500 psi.

MIRACLE IN ARABIA

Twenty-one Model T-1 ALCO Aircoolers with 3 fans per unit, handle all water cooling requirements at each of five pumping stations on the Trans-Arabian Pipe Line.

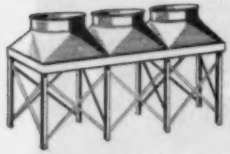
ALCO Aircoolers use Hot Desert Air to Cool Water for Tapline Pumping Stations

Cooling jacket water and lube oil cooling water for engines and generators at the pumping stations of the Trans-Arabian Pipe Line is a real engineering feat. Ground or surface water in expendable quantities is not available and although the ambient temperatures range as high as 122° F., ALCO Aircoolers proved to be the economical answer.

ALCO Aircoolers handle all of the water-cooling needs for Tapline pumping stations except at the terminal—at altitudes up to 2700 feet above sea level —a total of 4770 G.P.M.

Dependability of ALCO Aircoolers was an important factor in their selection for this installation. The remote location of these pumping stations called for rugged equipment which would require a minimum of maintenance attention and withstand the ravages of periodic wind and dust storms.

There is little probability that the conditions in connection with your cooling needs are as severe as this one on the Arabian desert. You can be sure, however, that ALCO Aircoolers can solve your problem, too. Write today for a copy of the ALCO Aircooler booklet or see your nearest ALCO Sales Engineer at Chicago, Dunkirk, Houston, Kansas City, Los Angeles, New York or Tulsa. Plants: Dunkirk, New York and Beaumont, Texas.



ONLY ALCO HAS THE BIG 5

1 Low Cost
2 Flexible Design
3 Efficient Performance
4 Easy Maintenance
5 Quick Installation

ALCO

ALCO Products Division
AMERICAN LOCOMOTIVE COMPANY

In step with tomorrow—ALCO AIRCOOLERS, Heat Exchangers, Evaporators, Feedwater Heaters, Pressure Vessels, Pipe

If you're all "gummed up"

in a tough heat transfer problem

Specify..

Vogt Spiral, Spring Type Scraper
Patent No. 2,117,175

Vogt

SCRAPER TYPE CHILLERS

Photos show shop assembly without driving motor.

Fouling of the inner pipe surfaces of Vogt Chillers is eliminated, because they are swept clean continuously during operation by patented spiral, spring type scrapers. And these clean surfaces achieve the highest possible rate of heat transfer between the solution and the refrigerant.

VOGT DOUBLE PIPE TYPE CHILLERS are designed to use ammonia, brine, or cold dewaxed oil as the cooling medium. Oil or brine, when employed, is circulated through the jacket pipes countercurrent to the flow of the solution in the inner pipes.

MULTI-PIPE TYPE CHILLERS, for direct expansion, have large jacket shells, each containing seven inner pipe sections and employ volatile refrigerants such as ammonia, freon, propane, etc.

Our engineering staff is qualified by training and experience to help you find the right answers to your heat transfer problems. Their recommendations are available without obligation.

HENRY VOGT MACHINE CO.
INCORPORATED
LOUISVILLE 10, KENTUCKY
BRANCH OFFICES: NEW YORK, PHILADELPHIA, CLEVELAND, CHICAGO, ST. LOUIS, DALLAS

ALCOA

Alcoa Heat Exchanger News

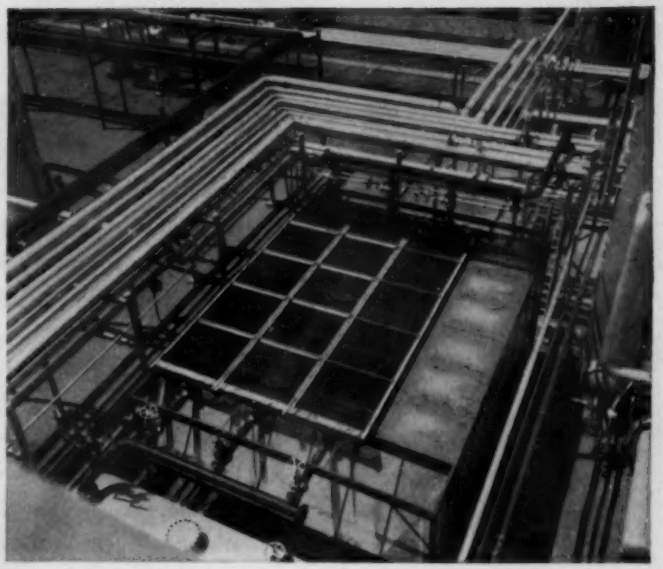
Published by Aluminum Company of America

Rearmament needs severely limit the manufacture of aluminum heat exchanger tubes. But we realize that the purchase of refinery and processing equipment requires long study of economic and performance factors. That is the reason for this message.

Skelly Oil Company Saves 50%

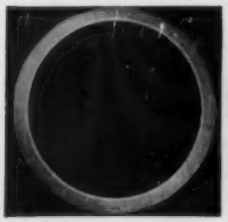
IN TUBE COSTS ON AIR COOLED EXCHANGERS

At their Eunice No. 2 gasoline plant near Eunice, New Mexico, Skelly Oil Company has installed a "Fin-Fan" air-cooled unit equipped with "aluminum tubes" and "aluminum fins" as a condenser for "Still Overhead Vapors." The company's engineers chose this type of condensing equipment because the atmosphere contained hydrogen sulfide and the vapors contained hydrogen sulfide and water in corrosive quantities. In addition there was a shortage of suitable cooling water. Aluminum tubes and fins were preferred to steel or Admiralty tubes with copper fins because of their resistance to hydrogen sulfide corrosion and lower investment cost. In this particular installation Fluor Fin-Fan designed equipment with Griscom-Russell K finned aluminum tube sections was used. The aluminum tubes are rolled into cast-iron headers and no cathodic protection has been necessary. These units have been in service for over two years—show no sign of corrosion—should last 12 to 15 years based on past experience with aluminum.



ALCLAD TUBES . . .

a bargain in cooling water corrosion resistance



HOW THEY WORK

The thin zinc-aluminum alloy internal layer galvanically resists corrosion of the base aluminum alloy structure of the tube—acts like a "built-in" anode. Corrosion is confined within the integral cladding layer. Even when large areas of the Alclad coating have been destroyed by electrolysis, the rest of the coating still protects the exposed alloy core. Alclad Tubes have withstood such corrosive attack for more than 17 years.

WHAT THEY COST

Foot for foot, metal for metal, Alclad Tubes cost less than any other tubes except bare aluminum. 20% less than ordinary steel. 47% less than Admiralty brass. 83% less than stainless steel.

ALCOA OFFERS BOOKLET

This 24-page booklet will answer many of your questions about Alcoa Tubes. It covers fabrication techniques, alloy selection, chemical and petroleum applications. It describes tube cleaning, inhibitors, cathodic protection. It contains complete information on fluid flow and heat transfer. There are formulas, tables and specification data. Write for your free copy today. ALUMINUM COMPANY OF AMERICA, 1864G Gulf Building, Pittsburgh 19, Pennsylvania.

It's LONG RANGE service . .

Any refinery is only as profitable as its day-to-day operating efficiency. That's why Universal Service continues beyond all others. It begins with basic and applied research and carries on through process design . . . planning of new, expanded or modernized plants . . . construction supervision . . . and lives with the job long after the finished plant is on stream.

From there, this unique Service goes on to provide the operational assistance of field men who are familiar, not only with *your* refinery but with refineries in all parts of the world. This assistance always is available on request whenever you need it.

UNIVERSAL OIL PRODUCTS COMPANY

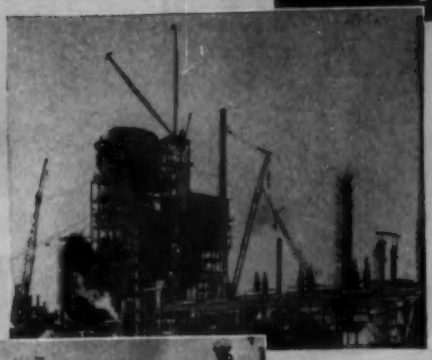
UOP

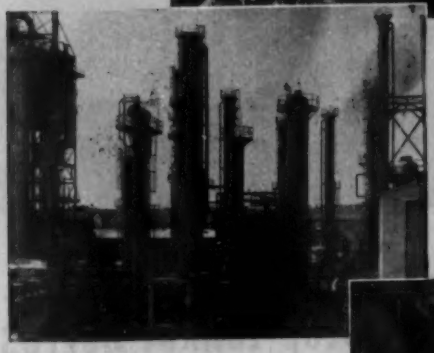
General Offices: 310 S. MICHIGAN AVE., CHICAGO 4, ILLINOIS, U.S.A.
Laboratories: RIVERSIDE, ILLINOIS

Universal Service Protects Your Refinery

FROM IDEA—

. . that counts!





TO DAILY OPERATION

try SANTOLENE C to stop tanker corrosion

Internal corrosion in tankers may cost you as much as $90,000 a year in maintenance, including cost of critical materials, down time and manpower. Examine Santolene C, corrosion inhibitor for light petroleum products, as a means of controlling tanker corrosion.

Santolene C, added to the light petroleum cargo, is believed to form a protective coating on metal. This coating remains to protect the ship when condensation covers the empty hold or when sea water is used for ballast.

Santolene C has also been proved effective in the laboratory and in product pipe-line service. Results have been confirmed through use by a major oil company which, for more than a year, has marketed all types of light petroleum products.

Santolene C is product-soluble. It burns completely with the fuel, leaving no residue. Diesel and gasoline engine tests have proved that Santolene C does not reduce engine cleanliness, causes no injector fouling, has no adverse effect on any factor of engine performance.

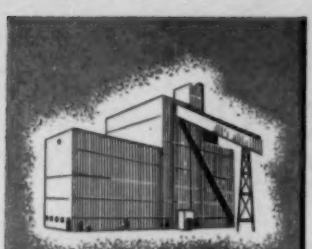
If you have a corrosion problem with light petroleum products in refineries, pipe lines, tanks, tank cars or tankers, Santolene C may solve it for you. For technical information on the use of Santolene C, write, wire or telephone MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1775-G So. Second Street, St. Louis 4, Missouri.

URGENT—If you have empty carboys or returnable drums, please return them to your supplier promptly. They're urgently needed. Containers are scarce!

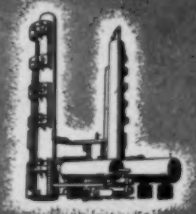
Santolene: Reg. U. S. Pat. Off.

MONSANTO
CHEMICALS — PLASTICS

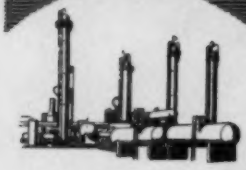
SERVING INDUSTRY .. WHICH SERVES MANKIND



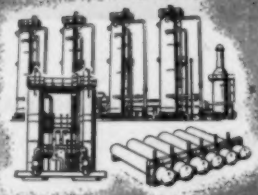
POWER DIVISION



CHEMICAL DIVISION

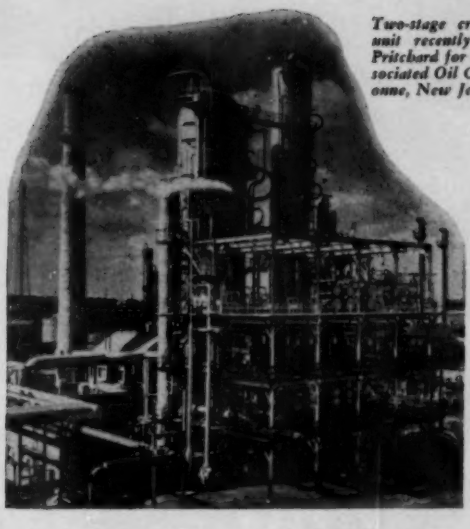


PETROLEUM DIVISION



NATURAL GAS DIVISION

DESIGN ENGINEERING and CONSTRUCTION for INDUSTRY



Two-stage crude distillation unit recently completed by Pritchard for Tide Water Associated Oil Company at Bayonne, New Jersey.

Pritchard Designs for Versatility and Accessibility

This unit is typical of Pritchard's forward looking ingenuity in Design, Engineering and Construction. Designed to the customer's requirements for replacement of an existing crude unit and for processing six different types of crude oil at a nominal capacity of 22,500 bbls. day, this unit simultaneously produces eight different distillate fractions ranging from light gasoline to cylinder stock!

At the same time particular care was taken to design the unit for maximum accessibility to the heat exchanger equipment, thus facilitating handling and reducing "shut down" time and maintenance costs.

For the most modern advancements in petroleum processing, let Pritchard engineers develop your next project from drawing board to "on stream."

Our Single Responsibility Contract includes:

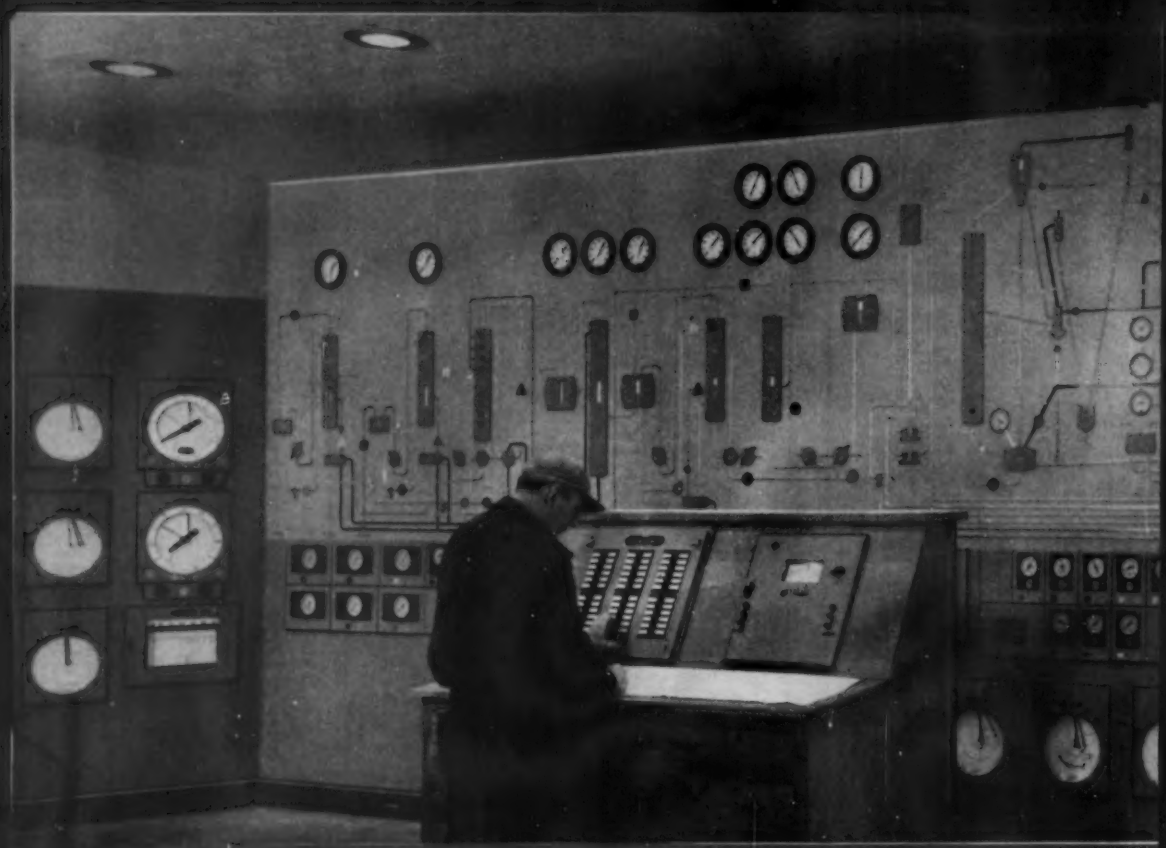
Economic Studies
Design
Processing
Engineering
Purchasing
Field Construction
Guarantees
Operating Tests
Firm Prices Quoted on a "Turnkey" Basis

J.F. Pritchard & Co.

DESIGN • ENGINEERING • CONSTRUCTION

Dept. No. 60 908 Grand Ave., Kansas City 6, Mo.

District Offices:
Chicago • Houston • New York • Pittsburgh • Tulsa • St. Louis

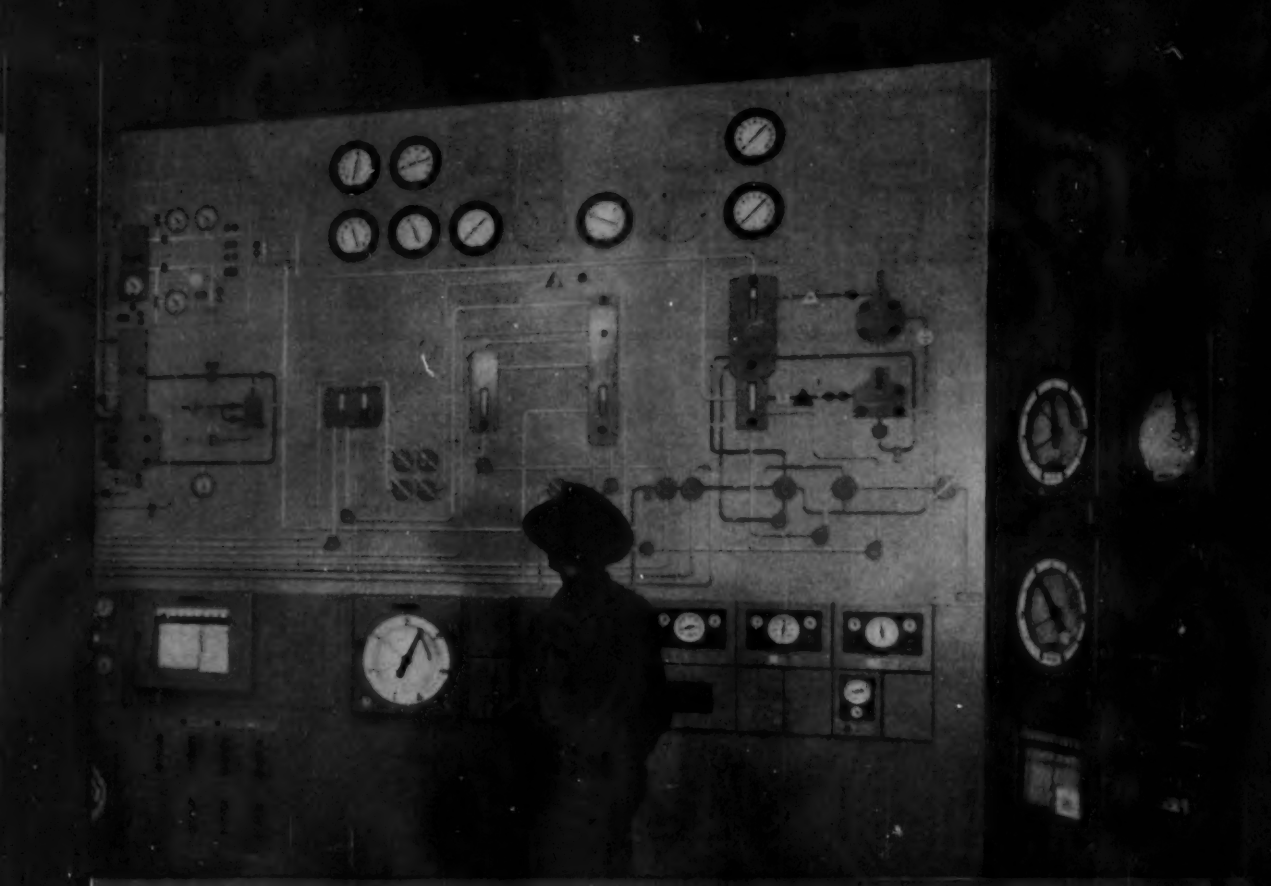


This *Color Grafic* panel

THIS new Brown *Color Grafic* Panel at the Great Lakes Refinery of Petco Corporation dramatically illustrates, in panoramic style, all symbols and flow lines of four complete processes. The details of Houdriflow*, polymerization, gas recovery and feed preparation are easily followed and controlled. Twelve different colors are used to indicate such flows as high pressure condensate, reactor charge and gasoline, product gas, air, catalyst, and others.

This consolidated control of the four processes lowers operating expenses . . . increases operator convenience . . . and reduces training time for personnel, even when the trainee has little or no previous knowledge of the process being controlled.

*Constructed by Catalytic Construction Company, Philadelphia, Pa.



spotlights multi-process control

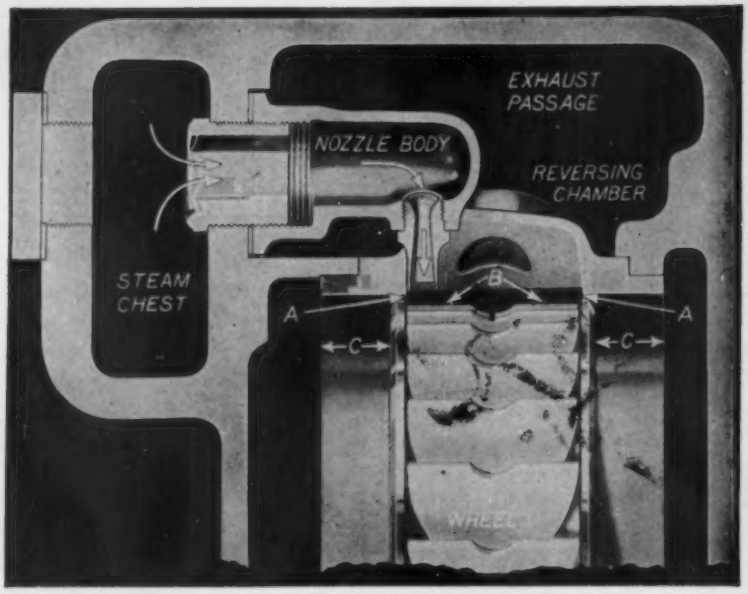
Such instrumentation permits the separation of recording and controlling functions—thereby, affords the opportunity to utilize improved mechanisms like the Brown mercuryless Differential Converter. Space is saved through smaller control areas. Installation is easy . . . start-up is simplified.

Vol. 5 No. 3 of INSTRUMENTATION contains a detailed description of this installation. Write for a copy . . . and for folder No. 228-1 on *ColorGrafic* Panels.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4498 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell
Brown Instruments

TERRY



AMPLE CLEARANCES FOR DEPENDABILITY

Large blade and rim clearances and extra large side clearance — one inch — help make Terry One-piece Wheel Turbines highly dependable in operation.

The blades cannot foul because of the protection afforded by the rims, which are not damaged, should rubbing occur.

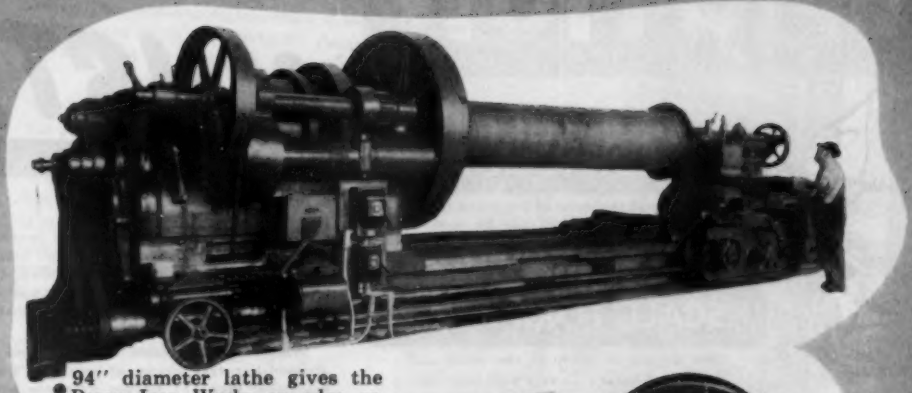
Note the rim clearance, AA in diagram. Also the large blade clearance, B. Side clearance, CC, is so large that end-play from external thrust cannot damage wheel.

Terry Bulletin S-116 will give you full information on the Terry Wheel Turbine. A request on your business letterhead will bring you a copy.

T-1171

THE TERRY STEAM TURBINE COMPANY
TERRY SQUARE, HARTFORD, CONN.

for Your Share of that Extra
75,000 BBLS. PER DAY



● 94" diameter lathe gives the Posey Iron Works an edge on large jobs requiring lathework

Crude-oil input capacity of United States refineries is currently scheduled for an increase of 75,000 barrels per day. That means expansion of storage facilities to keep pace with production equipment now being installed.

For decades, Posey Iron has served the refinery industry with storage equipment especially designed to meet the requirements of the petroleum and L-P gas fields. Posey Iron engineering is based on a *practical* knowledge of the industry . . . the sort of "shirt-sleeves" knowledge that eliminates needless tardiness in delivery . . . needless increase in cost. Consult Posey about your storage requirements.

● View shows bottom of recently erected 200,000 gallon Posey Iron Elevated Tank.

PRESSURE VESSELS — FRACTIONATING TOWERS
ELEVATED TANKS — STORAGE TANKS
LARGE DIAMETER FABRICATED PIPING
GENERAL STEEL PLATE CONSTRUCTION

POSEY IRON WORKS, INC.

Steel Plate Division • Lancaster, Pa.
New York Office: Graybar Building

DIVISIONS: BRICK MACHINERY . . . INDUSTRIAL HEATING . . . IROQUOIS . . . SHIPBUILDING . . . STEEL PLATE.

HEAT EXCHANGER MAINTENANCE IS NOW A MUST!

CAUTION

CORROSION

Eating away the metal of tubes and shells. Chemical neutralization can be used in some cases. Selection of proper tube and shell metals beforehand is best way to combat corrosion.

SCALE FORMATION

The deposit of solids on the inside and outside of tubes . . . very poor heat conductors. Cutters, vibrators, sand blasting will keep scale formation down.

GUM ACCUMULATION

Gum is a bad heat conductor too. Get rid of it by the proper chemical cleaning and brushing.

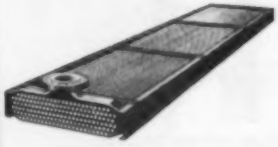
The extreme 24 hour service load in refining, and processing together with the high temperatures, high pressures, and fluids handled, create maintenance problems on heat transfer equipment which make it difficult to wring out that last ounce of service so vitally needed today.

When corrosion, scale formation and gum accumulation take charge of your heat transfer equipment they (1) Reduce efficiency because of the insulating properties of the scale; (2) Cost valuable time through overly extended cleaning periods; (3) Increase maintenance expenses in cleaning equipment and man hours; (4) Step up the depreciation of your equipment.

With an eye on the future, we at Western are encouraging old and new customers alike to look carefully at their operational and maintenance records. We are, right now, hitting hard on the idea of replacement, for in many cases heat exchangers now in operation have already passed the point of economical and efficient service. We serve the petroleum, chemical processing, refining, and pipeline industries and will be glad to consult with YOU on YOUR heat exchanger needs.

Look to Western for all your requirements in Shell-and-Tube Exchangers, Atmospheric Sections, Floating Head Exchangers, and Reboilers. More detailed information on our facilities will be forwarded upon request.

WESTERN



SEE OUR CATALOG IN SWEET'S

PROVIDED FOR YOUR CONVENIENCE

SEE OUR CATALOG IN REFINERY CATALOG

SALES REPRESENTATIVES

TRIDENT ENGINEERING COMPANY
16 Beale St. San Francisco

JACKSON ENGINEERING COMPANY
6144 Ferguson Dr. Los Angeles

TEMA

WESTERN HEAT EXCHANGERS

Manufactured by

WESTERN SUPPLY COMPANY

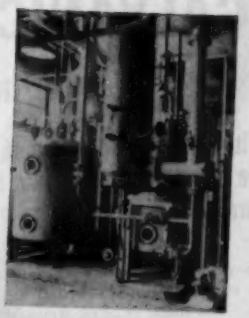
P.O. BOX 1888 TULSA, OKLAHOMA

SALES OFFICES — DALLAS — HOUSTON

Improve Plant Performance

...REDUCE INSULATING COSTS

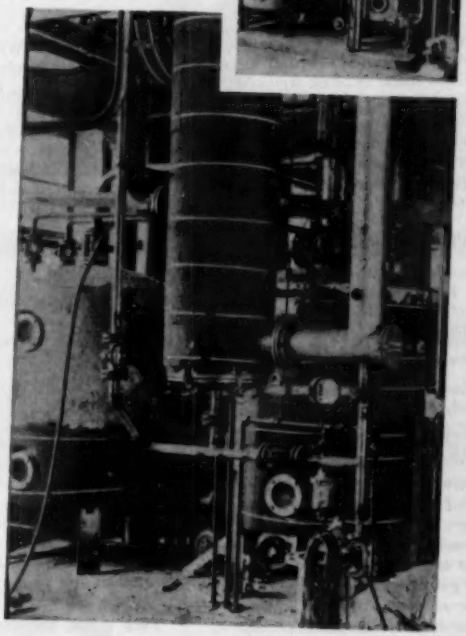
When you improve temperature control you can run your plant more efficiently. With PC Foamglas you can control temperatures more exactly, more economically.



Here's why: Since it consists of still air sealed in minute glass cells, Foamglas is an excellent barrier to heat transfer. Glass has unusually high resistance to many elements that cause insulation to deteriorate. Consequently, long lasting, trouble free service, makes Foamglas the least expensive insulating material.

PC Foamglas is available in standard flat blocks, curved segments and beveled lags, to fit equipment sides, heads and domes, and in preformed sections for standard size pipe and fittings.

We invite you to send in the coupon for a sample of PC Foamglas, and for free literature containing complete information.



This typical equipment, used in a process where temperatures range from 0°F. to 200°F., is insulated with curved segments of PC Foamglas. Insulation Contractor: Combustion Equipment & Insulation Company, Cleveland, Ohio.

PITTSBURGH CORNING CORPORATION, PITTSBURGH 22, PA.

The **best** glass insulation is cellular glass. The **only** cellular glass insulation is PC Foamglas. This unique material is composed of still air, sealed in minute glass cells. It is light-weight, incombustible, verminproof. It has unusually high resistance to moisture, chemicals and many other elements that cause insulation to deteriorate.

Pittsburgh Corning Corporation
Dept. EE-71,307 Fourth Avenue
Pittsburgh 22, Pa.

Please send me without obligation a sample of Foamglas and your FREE booklet on the use of PC Foamglas for Industrial Insulation.

Name.....

Address.....

City.....State.....

PITTSBURGH PC CORNING

FOAMGLAS cellular glass INSULATION

...when you insulate with FOAMGLAS... the insulation lasts!

Some important facts about

GALVANIC CORROSION

and how you can control it

With strict conservation of basic defense materials again the order of the day, this brief discussion of bi-metallic corrosion may save you a few unnecessary headaches

When two dissimilar metals are coupled in a corrosive liquid – brine, for example – one metal is often attacked by corrosion at a faster rate than usual.

The second metal may remain free from attack. Or it may be corroded at a slower rate than usual.

This type of corrosion is known as "galvanic corrosion."

What to look for

Before blaming galvanic action for corrosion in your equipment, you should first determine whether these three conditions exist:

1. **Are the metals different?**
2. **Are they surrounded by an electrolyte?**
3. **Are they in electrical contact through a metallic path?**

A "yes" answer to all three questions should send you to the "Galvanic Series" chart reproduced at the right. Here the metals are listed in the reverse order of their "nobility" or resistance to galvanic corrosion.

Galvanic corrosion usually results in a higher rate of corrosion of the "less noble" metal, and protection of the "more noble" metal.

How to use the chart

Notice how the metals are grouped. Any metal in one group can safely be used with any other metal in its own group. When you start mixing metals from different groups, however, you may run into serious galvanic corrosion of the metal higher on the list. And the further apart the metals stand, the worse this corrosion may be.

Another thing to consider in using different metals, too, is the electrical contact between them. When the metals are separated or insulated in some way, galvanic corrosion is checked.

And a third factor to keep in mind is the relative areas of the two metals. If they are in contact with each other, make sure that the parts having the smaller area are more noble than those having the larger area.

Application

With these principles as a guide, you can tell which metals are apt to produce strong galvanic corrosion. And you can tell which are relatively safe to use in contact with each other. For example, Monel fastenings could be used on a steel tank holding a liquid without fear of galvanic corrosion.

Why? Because the relative areas of the two metals are such that the area of the less noble metal, steel, is much greater than that of Monel. Since the magnitude of the galvanic action depends to a large extent on this area ratio, corrosion in the steel will not be accelerated to any appreciable extent.

Two good suggestions

1. Write for our free booklet, *Corrosion—Processes, Factors, Testing.* It contains a thorough explanation of galvanic corrosion, with data on the characteristics of Monel, Nickel and Inconel.

2. If you have a metal problem, take it up with INCO's Corrosion Engineering Service. Available data from their files for a particular combination of metals will be furnished wherever possible. And Corrosion Engineering will be glad to help you apply general principles of galvanic corrosion control to your specific problems.

GALVANIC SERIES OF METALS AND ALLOYS

Corroded End
(anodic, or least noble)

▼

Magnesium
Magnesium alloys

▼

Zinc

▼

Aluminum 2S

▼

Cadmium

▼

Aluminum 17ST

▼

Steel or Iron
Cast Iron

▼

Chromium-iron (active)

▼

Ni-Resist

▼

18-8 Stainless (active)
18-8-3 Stainless (active)

▼

Lead-tin solders
Lead
Tin

▼

Nickel (active)
Inconel (active)

▼

Brasses
Copper
Bronzes
Copper-nickel alloys
Monel

▼

Silver solder

▼

Nickel (passive)
Inconel (passive)

▼

Chromium-iron (passive)
18-8 Stainless (passive)
18-8-3 Stainless passive)

▼

Silver

▼

Graphite
Gold
Platinum

▼

Protected End
(cathodic, or most noble)

EMBLEM OF SERVICE INCO TRADE MARK

THE INTERNATIONAL NICKEL COMPANY, INC.

67 Wall Street, New York 5, N. Y.

PRESSURE TIGHT WITHOUT LUBRICATION

- NEW TEFLON-SEAL STUFFING BOX
- CUTS METER MAINTENANCE
- ELIMINATES LEAKS
- ELIMINATES SHAFT FREEZING

STANDARD IN
1800 PSI
ORIFICE METERS

Teflon-Seal Stuffing Boxes have been operating for more than two years without servicing in thousands of orifice meter installations! Applications such as sour gas, wet gas, caustic solutions — almost every conceivable service — have failed to impair meter operation. Maintenance problems are drastically reduced or eliminated!

The Teflon-Seal bearing is pressure-sealing around a precision made, centerless-ground Monel metal shaft, *without grease and with minimum friction.* All other stuffing box parts are corrosion resistant stainless steel. The Teflon-Seal Stuffing Box is suitable for ambient meter temperatures to 150°F. and working pressures to 1800 psi. Units are adaptable to older types of orifice meters now in service.

Here is another example of American Meter Company's policy of constant product improvement to uphold a century-old tradition of "*Sustained Accuracy at Lower Cost.*"

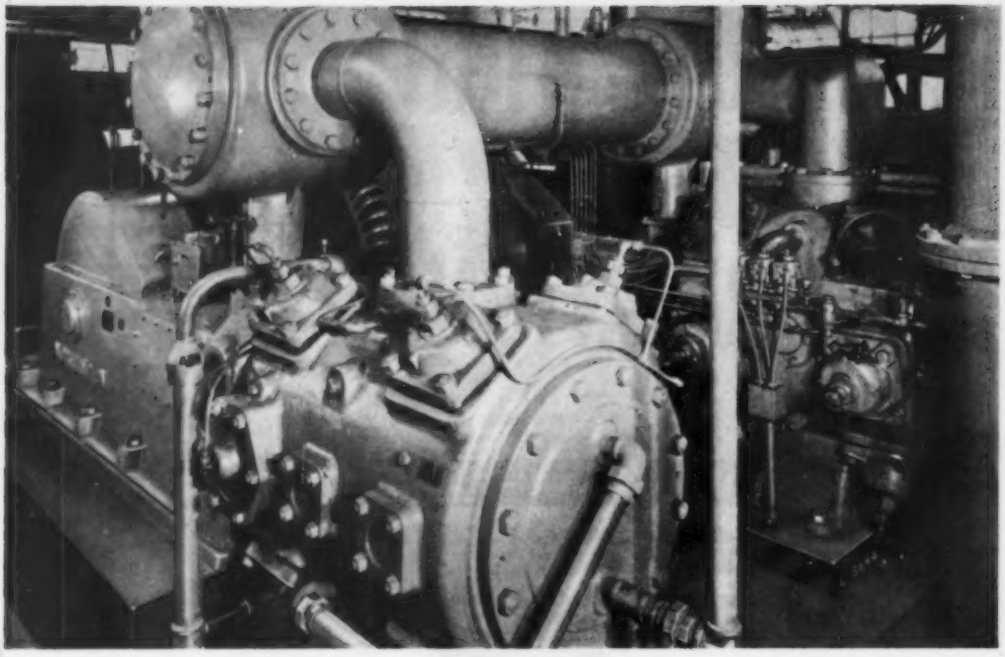
See our display, booth 101-5, *Sixth National Instrument Exhibit*, Sam Houston Coliseum, Houston, Texas, September 10-14.

PROPERTIES OF TEFLON

Teflon (polytetrafluoroethylene) is a synthetic polymer with the following properties: low coefficient of friction — zero water absorption — high impact strength — toughness — form stability — and exceptional chemical inertness. It retains strength at temperatures from —100°F. to 550°F. and does not stick or "weld" to other materials. It resists the attack of all known solvents except molten alkali metals, with no change in weight or properties.

GENERAL SALES OFFICE: 1513 Race St., Philadelphia
Albany • Alhambra • Amarillo • Atlanta • Baltimore
Birmingham • Boston • Chicago • Dallas • Denver • Erie
Houston • Kansas City • Los Angeles • New York • Odessa
Pittsburgh • San Francisco • Tulsa • Hamilton, Ontario

AMERICAN METER COMPANY
INCORPORATED ESTABLISHED 1892



Only Pennies for maintenance!

Except for replacement of a valve strip after many months of service, the Worthington Air Compressors at Standard Oil Company in Baltimore have operated two, three and four years without any maintenance expense.

Such performance proves the economy and dependability of the Worthington Air Compressor. In addition to the exclusive Worthington Feather* Valve (simplest, lightest, tightest ever built), the DC2 model illustrated above also has Worthington's own automatic variable capacity control—most accurate, flexible and simple control available. And Worthington's high-efficiency intercooler needs less water, less power, less attention.

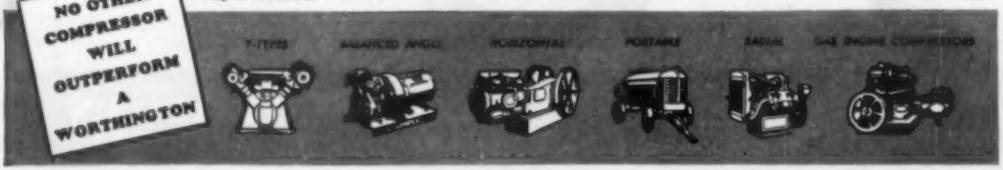
To become familiar with the "why" of Worthington's 50-year leadership in compressors, write for bulletins on Worthington compressors. And for a wide range of equipment for the petroleum industry, ranging from pumps and engines to refrigeration equipment—investigate the *more worth in Worthington.* Worthington Pump and Machinery Corporation, Compressor Division, Buffalo, New York.

WORTHINGTON

*Reg. U. S. Pat. Off.

K.1.3

NO OTHER COMPRESSOR WILL OUTPERFORM A WORTHINGTON



Up...up...up where the weather is rough!

Houdriflow Catalytic Cracking Unit, Sun Oil Company's Woodville Road Refinery, Toledo, Ohio. Contractor: Catalytic Construction Co., Philadelphia, Pa. "Century" Asbestos Corrugated Sheets erected by Elwin G. Smith & Company, Pittsburgh, Pa., and Toledo, Ohio.

Men and equipment are permanently protected by "Century"® Corrugated Asbestos-Cement Sheets

High on the side of this catalytic cracking tower there are no wind breaks . . . no shade . . . nothing to block driving rain and the fury of storm. Yet inside the elevator tower it's always dry . . . always protected . . . always "a nice day." "Century" Corrugated Asbestos-Cement Sheets make a completely weather-tight enclosure—give permanent protection to men and equipment.

And, despite the fact that the tower is exposed to the elements, maintenance will never be a problem. For in addition to resisting weather, "Century" Asbestos Corrugated *can not burn, rot, or rust*—rodents and termites can't hurt it. It doesn't even need protective painting to preserve it. Consider the maintenance costs these characteristics save!

"Century" Asbestos Corrugated can be applied quickly, easily, inexpensively. The large-size sheets are exceptionally strong, but they can be cut and drilled with ordinary working tools—can be fastened in place with a minimum of labor.

Whatever your building plans—new construction, expansion, or modernization—it will pay you to consider cost-saving "Century" Corrugated Asbestos-Cement Sheets for both siding and roofing. We'll be glad to send complete details on request.

Nature made Asbestos . . .
Keasbey & Mattison
has made it serve mankind since 1873

K&M Best in Asbestos®

KEASBEY & MATTISON
COMPANY • AMBLER • PENNSYLVANIA

better measurement and control of

PRESSURE

From vacuum to 80,000 psi . . .

Whether the critical pressure of your process is full vacuum, 80,000 psi, or any range between . . . the complete diversity and engineering quality of Foxboro Instruments provide a means to measure or control it with highest accuracy and reliability. Add to this an unequaled experience in applying instruments to solve processing problems, and you have the reason for Industry's preference for Foxboro Pressure Instrumentation.

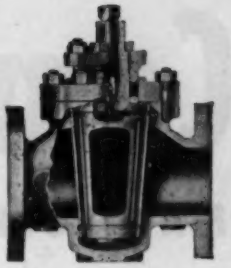
INDICATORS · RECORDERS · CONTROLLERS
TRANSMISSION SYSTEMS · CONTROLLED VALVES

FOXBORO
Reg. U. S. Pat. Off.

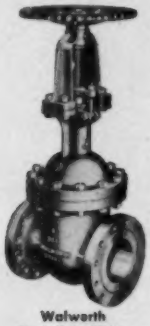
For over 40 years, specialists in the measurement and control of temperature, pressure, flow, liquid level, humidity . . .

THE FOXBORO COMPANY · FOXBORO, MASSACHUSETTS, U.S.A.

• VALVES
• PIPE FITTINGS



Walworth
Lubricated Plug Valve



Walworth
Steel Gate Valve

Walworth
Iron Body Gate Valve

Walworth
"500 Brinell" Bronze Globe Valve

Walworth
Iron Body Saddle Gate Valve

Walworth
Cast Steel Flanged Fittings

Walworth manufactures a *complete line* of valves and pipe fittings: all made to the highest standards of quality, both as to dimensional accuracy and metallurgical properties. In design, construction, and performance, Walworth products reflect more than a century of experience in the manufacture of quality valves and fittings.

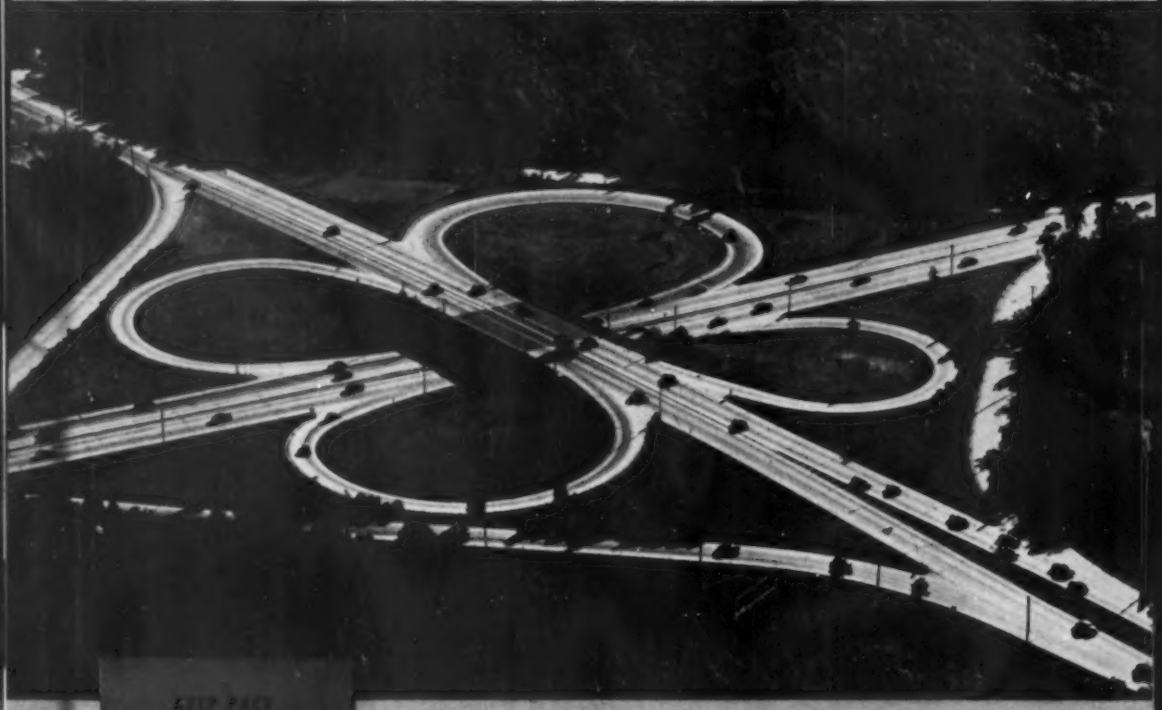
Your Walworth distributor will give you full information on the *complete line* of Walworth steel, iron, and bronze, and special alloy valves and pipe fittings; also Walworth Lubricated Plug Valves, and Walseal* valves, fittings and flanges. Ask for this information today.

*Patented—Reg. U. S. Pat. Off.

WALWORTH
valves and fittings
60 EAST 42nd STREET, NEW YORK 17, N. Y.

DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD

Compare YOUR REFINERY MANIFOLDS WITH TRAFFIC CONTROLS



KEEP PACE WITH PROGRESS

MANIFOLDS—The traffic center of a refinery—are the arteries of flow that should be given first attention in a well-planned policy of valve replacements. By installing Nordstroms you avoid the possibility of mixing because a Nordstrom insures the most positive and complete shut-off. The more Nordstroms on a manifold, the faster the switching. Instead of taking an hour or more to turn a battery of conventional-type valves on or off, your operator can do it in a matter of minutes with Nordstroms.

TRAFFIC CONTROL is undergoing revolutionary changes in all principal American cities to avoid congestion and accidents and to save motorist's time. ☆ Cost-conscious refinery engineers are also adopting the sound plan of progressively replacing troublesome valves with Nordstroms to gain improved flow control.

ADOPT THIS GOOD HABIT—replace worn-out valves with Nordstroms. Be sure your requisition specifies Nordstrom. This will give you a good opportunity to *compare* Nordstrom performance with other valves on the same service. Eventually your manifolds will be completely modernized—for improved flow control, safer operation and faster manipulation. The cost of replacing with Nordstroms is competitive with conventional valves.

ADOPT THE PROGRESSIVE HABIT...REPLACE OLD VALVES WITH NORDSTROMS

Modernize your Manifolds with

Nordstrom Valves

NOW AUTOMATICALLY LUBRICATED WITH Hypermatic

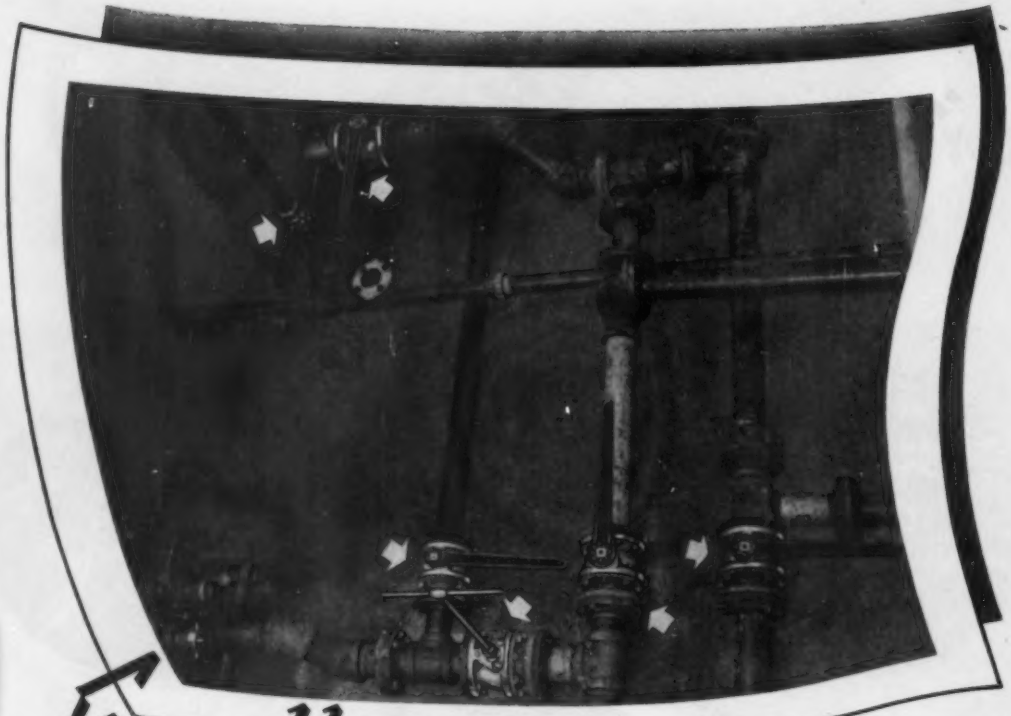
TRADE MARK

PATENTS APPLIED FOR

ROCKWELL MANUFACTURING COMPANY

400 North Lexington Avenue • Pittsburgh 8, Pennsylvania

Atlanta, Boston, Chicago, Columbus, Houston, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco, Seattle, Tulsa . . . and leading Supply Houses. Export: International Division, Rockwell Manufacturing Company, 7701 Empire State Bldg., New York 1, N. Y.



Exactly RIGHT FOR THE JOB . . .

ROCKWOOD Ball VALVES

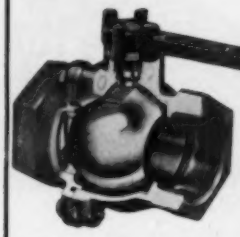
Wherever a rugged, longer lasting, quick opening and closing valve is needed, Rockwood Ball Valves will fill the bill perfectly. The full *round* flow, leak proof service, and no maintenance features of the Rockwood Ball Valve assures around the clock performance. Rockwood Ball Valves are already giving outstanding service in oil refineries, food, paper, textile, chemical and rubber plants . . . and many more! The group of Rockwood Ball Valves shown above controls the flow of water and various chemicals in a large testing laboratory.

Positive shut-off of every valve is important at all times.

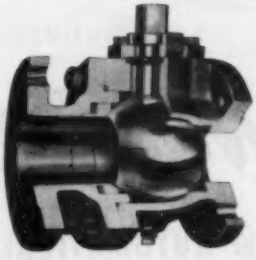
Seeing is believing — convince yourself by installing Rockwood Ball Valves in your plant, today. Send for folder V-4.

Distributors in all principal cities.

ROCKWOOD SPRINKLER CO.
102 HARLOW ST., WORCESTER 5, MASS.



Rockwood Ball Valve made of bronze with screwed ends is available in ⅛" to 2" pipe sizes. 300 p. s. i. working pressure.

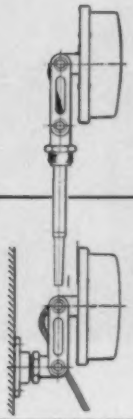


Rockwood Cast Steel Ball Valve available in 3" and 4" pipe sizes. Recommended for refinery, pipe line and general use. 300 W. O. G.

PALMER

mercury actuated Dial Thermometers

now in three types to suit any requirements

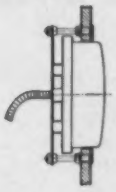


1 Rigid Stem Dial Thermometer

Rigid stem tapered bulb, interchangeable with standard industrial thermometer separable socket.

2 Wall Mounted Dial Thermometer

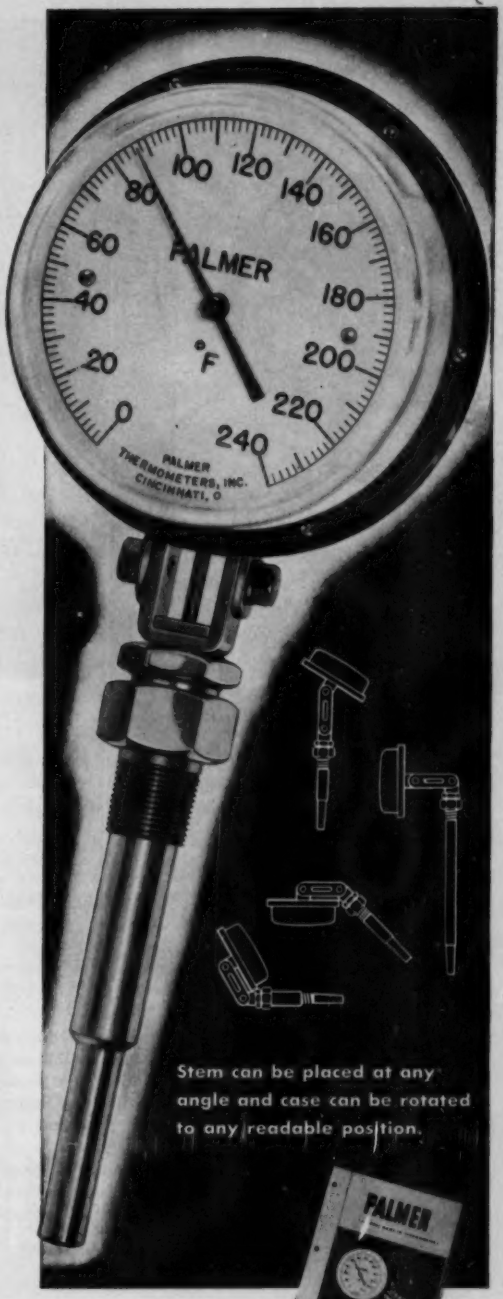
Wall mounted dial thermometer with flexible connecting armor. Case adjustable to easy reading position.



3 Flush Mounted Dial Thermometer

Flush mounted style for panel mounting with flexible connecting armor.

All three types have a full 4½" dial Face



Stem can be placed at any angle and case can be rotated to any readable position.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensation. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

SEND FOR THIS BULLETIN

For details on the New Palmer Dial Thermometer, please write for Palmer Bulletin 51-129.

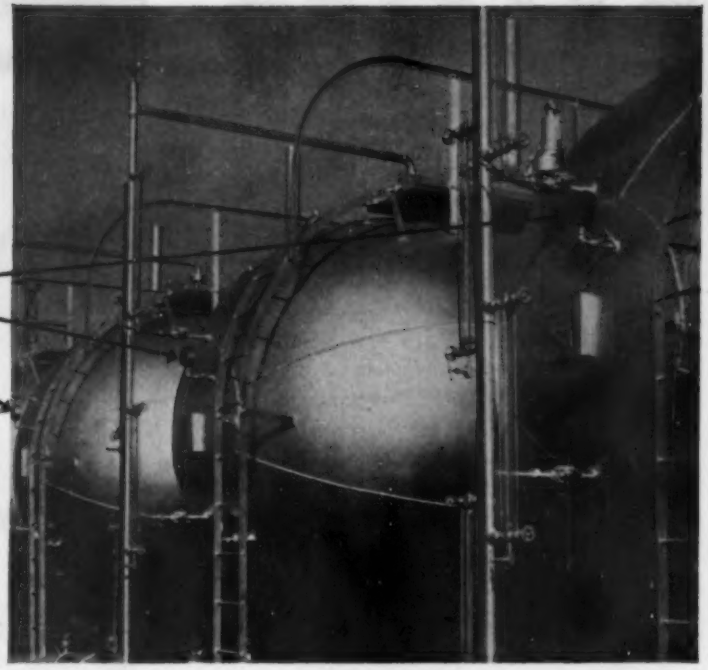
PALMER THERMOMETERS, INC.

Mfrs. of Industrial Laboratory, Recording and Dial Thermometers

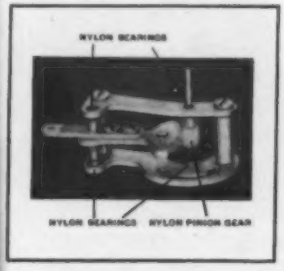
2515 NORWOOD AVE., CINCINNATI 12, O.

DURAGAUGE SPECIFIED!

Ashcroft Duragauges installed on spherical propane storage tanks at Carthage, Texas.



DURAGAUGE *Nylon Movement** OUTWEARS ALL OTHERS!



How to increase *wear resistance* in a pressure gauge was a stubborn problem—until Ashcroft engineers solved it. Now *only* the Duragauge has a Nylon Movement, *the movement that outwore all others* in extensive laboratory and field tests on the worst services to be found.

Ashcroft engineers recognized the value of lightness and the other characteristics of nylon and anodized aluminum and designed these materials into precision mating parts for the Duragauge. Result: low friction, high impact absorption, corrosion resistance and freedom from objectionable products of wear. Furthermore, the nylon pinion gear and bearings retain their precise form and shape under high temperatures. Consequently, the Nylon Movement provides greatly improved indication sensitivity and accuracy and longer life.

The Ashcroft Duragauge, with Nylon Movement, has proved its enduring dependability in new and old refineries, chemical plants and power stations. It is the unqualified standard for the most "killing" services.

Your Ashcroft Distributor will gladly give you complete facts about the Duragauge and how it can solve your pressure indicating problem.

*Pat. Applied for

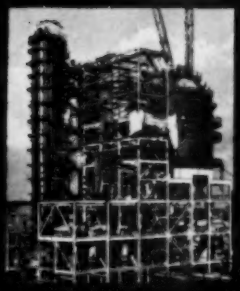
1850 ASHCROFT U.S.A.

ASHCROFT GAUGES

MANNING, MAXWELL & MOORE

A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONNECTICUT

MAKERS OF 'ASHCROFT' GAUGES, 'HANCOCK' VALVES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, 'AMERICAN' INDUSTRIAL AND 'MICROSEN' ELECTRICAL INSTRUMENTS. BUILDERS OF "SHAW-BOX" CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.



fluid catalytic cracking

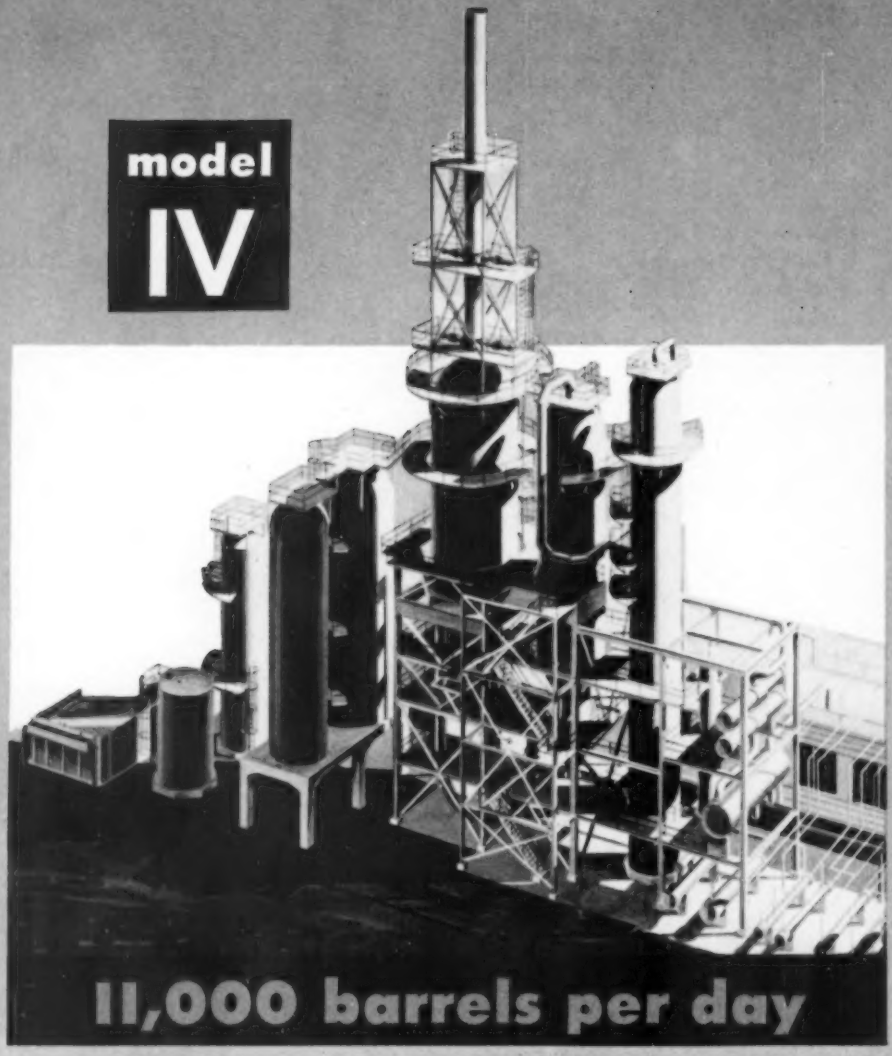
In building – as in operating – economy demands flexibility of many engineering functions. Flexibility – in both cracking and engineering – is a product of a comprehensive "know-how" . . . and "know-how" is the product of experience.

Foster Wheeler has designed and constructed Fluid Catalytic Cracking Units since 1941 and is now building 9 "fluid" units in different parts of the world. This experience, available to refiners – anywhere in the world – is the basic component of Foster Wheeler's complete engineering and construction service.

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

model IV



11,000 barrels per day

More barrels of high octane product per ton of steel used **is a factual statement which most adequately sums-up the many design improvements built into this new Fluid Catalytic Cracking Unit.**

The artist's drawing of the 11,000 bbl/day Model IV unit now being built by Foster Wheeler for Imperial Oil Limited, at Edmonton, Canada, highlights the compactness of this truly new "fluid" design. Two more Model IV units are being designed and constructed by Foster Wheeler.

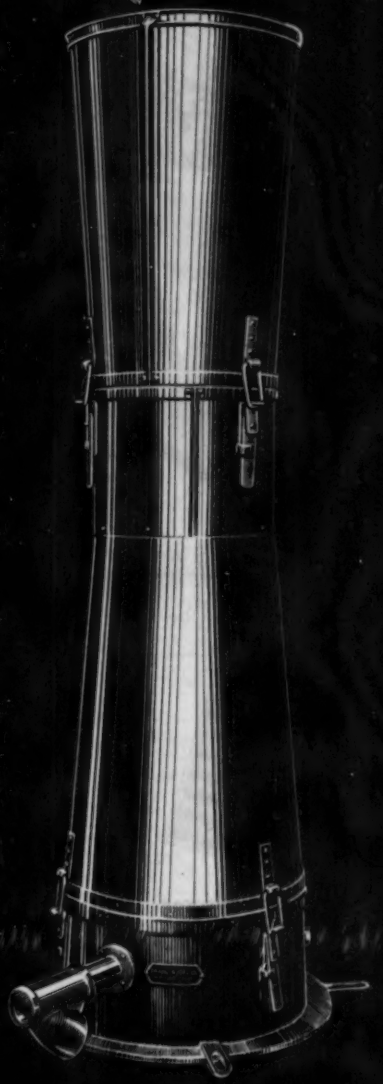
For further information, address your inquiries to:

FOSTER WHEELER CORPORATION

165 BROADWAY, NEW YORK 6, NEW YORK

"STEAM-EX" Saves 7 Ways

- ✓ Cuts in half time required to gas free storage tanks. "Steam-Ex" can exhaust about 300,000 cubic feet of air per hour.
- ✓ Readily portable. "Steam-Ex" is made in three easy to handle sections. It can be mounted on the manhole flange, assembled and put into operation faster than any other gas freeing system.
- ✓ One man can carry, assemble and operate "Steam-Ex."
- ✓ Operates with maximum efficiency on either steam or air.
- ✓ Requires less steam or air to gas free any given tank.
- ✓ One size fits all manhole flanges from 18" to 24" I.D., and from 24" to 30" O.D. inclusive.
- ✓ Long life of trouble free performance. The "Steam-Ex" housing is constructed of heavy guage black iron, and the nozzle is of all bronze. "Steam-Ex" has no moving parts . . . no maintenance problems. "Steam-Ex" is SAFE.



S&J

Shand and Jurs Co. 8TH AND CARLTON STREETS : BERKELEY : CALIFORNIA

NEW YORK 295 Madison Ave. CHICAGO 10409 S. Western Ave. HOUSTON 814 M & M Bldg. TULSA 310 Thompson Bldg. LOS ANGELES 714 W. Olympic Blvd. SEATTLE 3000 Western Ave.

MONTREAL, QUE., 360 Notre Dame St. West VANCOUVER, B. C., 550 Beatty St. FORT ERIE, ONT. DARLINGTON, ENG. CARACAS, VEN.

8-hour job now takes 4 hours

At a western magnesium reduction plant something besides magnesium has just been reduced. The steam at the end of the 1½ mile long steam line wasn't so hot—and neither was the production record of the plant at that location.

Then 26 old-type steam traps were replaced with Yarway Impulse Traps. Now there is only a 15° temperature drop from the boilers to the end of the line. *Most important, the plant 1½ miles from the boilers is now able to do work in 4 hours that previously took 8 hours.*

That's trap efficiency! It's evidence of the fact that Yarways are designed to send the most premium B.T.U.'s at top temperatures into your process or product. *They get equipment hotter, sooner . . . and keep it hot.*

Other Yarway features—small size, one moving part, easy installation, low maintenance, low cost, stainless steel construction. Nearly 750,000 Yarways have already been installed. For your Yarways, see a nearby industrial distributor . . . 216 stock and sell Yarways.

YARNALL-WARING COMPANY, 128 Mermaid Ave., Philadelphia 18, Pa.

FREE TRAP SELECTOR

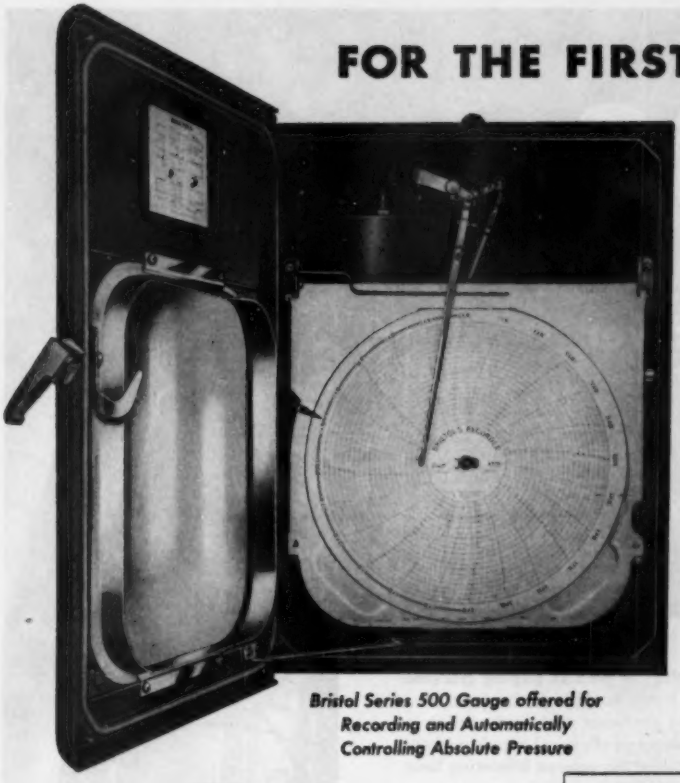
It's important to have the right trap in the right place. New 20-page selector tells quickly and easily which *is* the right Yarway trap for any application. Write for your free copy.

YARWAY

the steam trap

designed with more production in mind

FOR THE FIRST TIME



Bristol Series 500 Gauge offered for Recording and Automatically Controlling Absolute Pressure

Accurate Mechanical Recording and Controlling of Absolute Pressure

IN RANGES AS LOW AS 0 TO 6 MM!

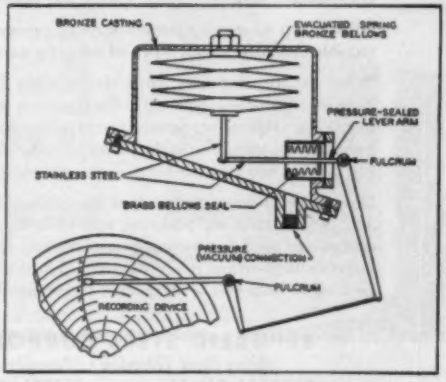
Again, Bristol scores a first!

Our new Low-Range Absolute Pressure Recording Gauge gives a direct reading of pressure above zero absolute, inherently corrected for barometric variations, with far greater accuracy than ever before possible—measuring ranges as low as 0 to 6 mm mercury absolute.

SINGLE BELLOWS—NO COMPENSATION NEEDED

Instead of *two* pressure elements—one for measured pressure, one to compensate for barometric pressure—Bristol uses a single calibrated bellows element, evacuated to practically a perfect vacuum, enclosed in a cast bronze pressure-tight housing. The bellows motion is transmitted outside the housing through an entirely new device—a pressure-sealed lever arm that is frictionless, entirely free from lost motion and turning moments due to changes in differential pressure across it.

Thus—with one measuring element, Bristol's Absolute Pressure Gauge operates in ranges hitherto considered impractical with metallic elements.



WHAT'S YOUR APPLICATION?

This entirely new, highly-accurate, direct-reading mechanical pressure instrument gives valuable information for controlling pressure wherever the operation of equipment depends upon a high and constant vaccum.

Bristol Low-Range Absolute Pressure Gauge is offered for recording, pneumatic or electric controlling, and pneumatic or electric remote transmission. For Bulletin G620, write THE BRISTOL COMPANY, 111 Bristol Road, Waterbury 91, Conn. (The Bristol Co. of Canada, Ltd., Toronto, Ont.; Bristol's Instruments Co., Ltd., Lynch Lane, Weymouth, Dorset, England.)

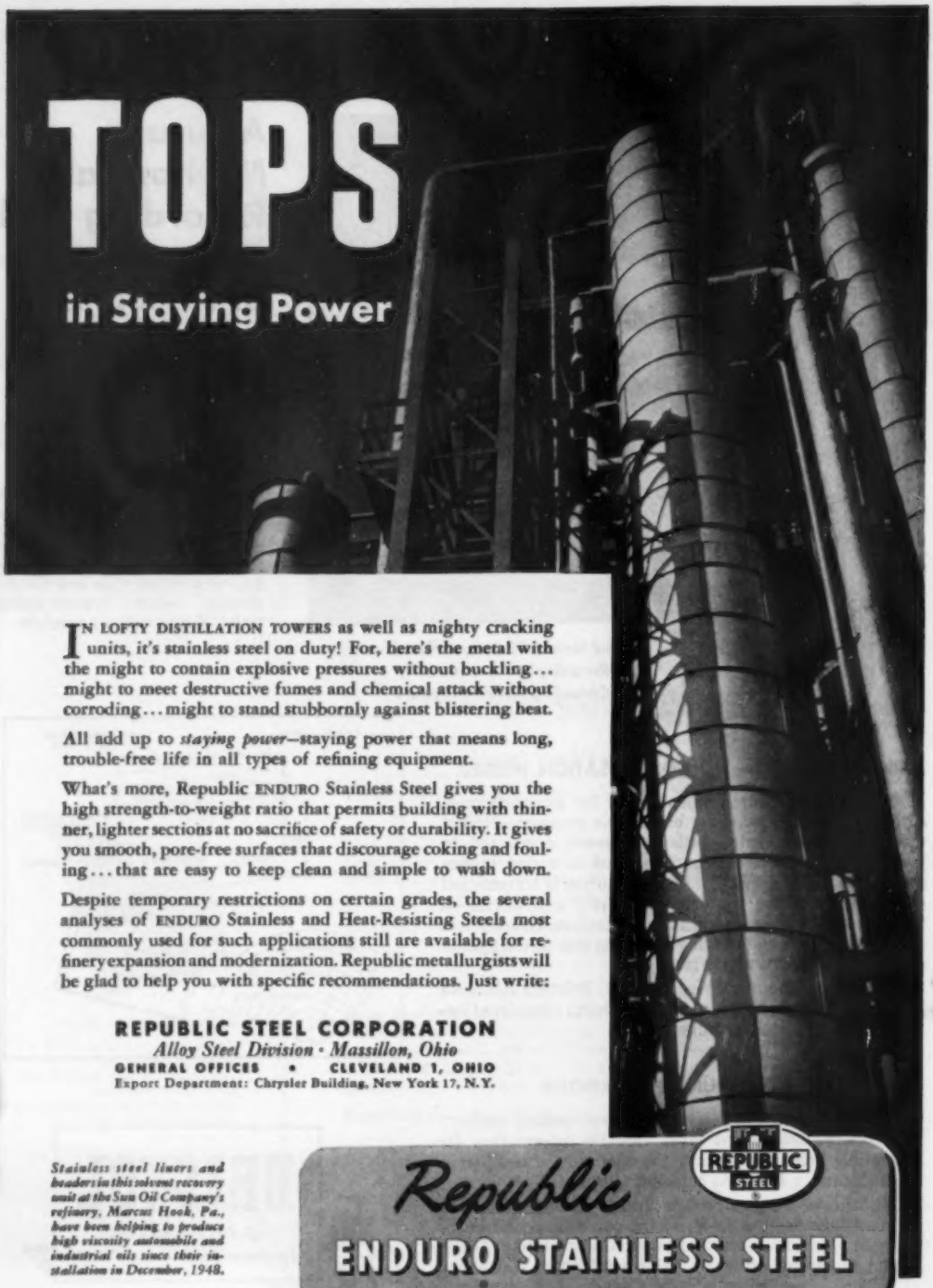
BRISTOL

Engineers Process Control for Better Products and Profits

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS

TOPS

in Staying Power



IN LOFTY DISTILLATION TOWERS as well as mighty cracking units, it's stainless steel on duty! For, here's the metal with the might to contain explosive pressures without buckling... might to meet destructive fumes and chemical attack without corroding... might to stand stubbornly against blistering heat.

All add up to *staying power*—staying power that means long, trouble-free life in all types of refining equipment.

What's more, Republic ENDURO Stainless Steel gives you the high strength-to-weight ratio that permits building with thinner, lighter sections at no sacrifice of safety or durability. It gives you smooth, pore-free surfaces that discourage coking and fouling... that are easy to keep clean and simple to wash down.

Despite temporary restrictions on certain grades, the several analyses of ENDURO Stainless and Heat-Resisting Steels most commonly used for such applications still are available for refinery expansion and modernization. Republic metallurgists will be glad to help you with specific recommendations. Just write:

REPUBLIC STEEL CORPORATION
Alloy Steel Division · Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

Stainless steel liners and headers in this solvent recovery unit at the Sun Oil Company's refinery, Marcus Hook, Pa., have been helping to produce high viscosity automobile and industrial oils since their installation in December, 1948.

Republic
REPUBLIC STEEL
ENDURO STAINLESS STEEL

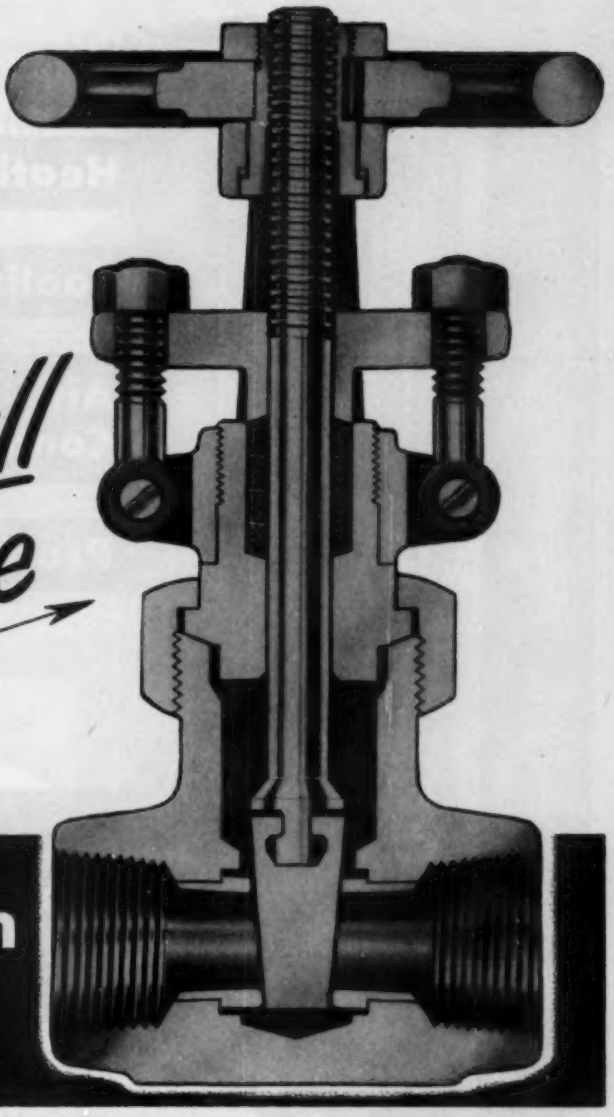
Other Republic Products include Upson Bolts, Studs, Nuts and Rivets—Pipe—Sheets—Plates—Electrunite Heat Exchanger Tubes

You can

Repack Under Full Pressure

with a

Chapman List 960



No pressure is transmitted to the stuffing box of a Chapman List 960 when the valve is in the open position . . . you can always repack it easily, fast, without stopping the flow through the valve. What's more, it's a tougher — more rugged — valve that reduces many other maintenance problems.

Take for instance, the wedge faces — they're hardened to 800 Brinell by the exclusive Malcomizing process to give peak wear resistance. Seat rings, too, have unusual wear-resisting and non-galling characteristics. And, in addition, recent design changes have resulted in stem and wedge gate connections 50% stronger than before.

Write *today* for detailed technical information. The Chapman List 960 is available in sizes from ¼" to 2", either metal to metal or gasketed joint. Rising stem with yoke (as illustrated) or rising stem inside screw type. For pressure range 2000 lbs. at 100 deg. F., 380 lbs. at 1000 deg. F. For higher pressures specify List 990.

The Chapman Valve Manufacturing Company

INDIAN ORCHARD, MASSACHUSETTS

Heating?

Cooling?

Air Conditioning?

Process?

Here's How to Get the RIGHT Answer to your HEAT-EXCHANGE PROBLEMS

The right ratio of surfaces – the right materials – the right velocities – the right proportion between coil area and depth . . . there are dozens of factors that affect the efficiency, maintenance and service life of heat-exchange coils.

For best performance in your own application, the practical approach is to take full advantage of the unequalled engineering, research and design skill – the unequalled manufacturing and testing facilities – which Aerofin offers you.

To get the *right* answer – ask the Aerofin man.

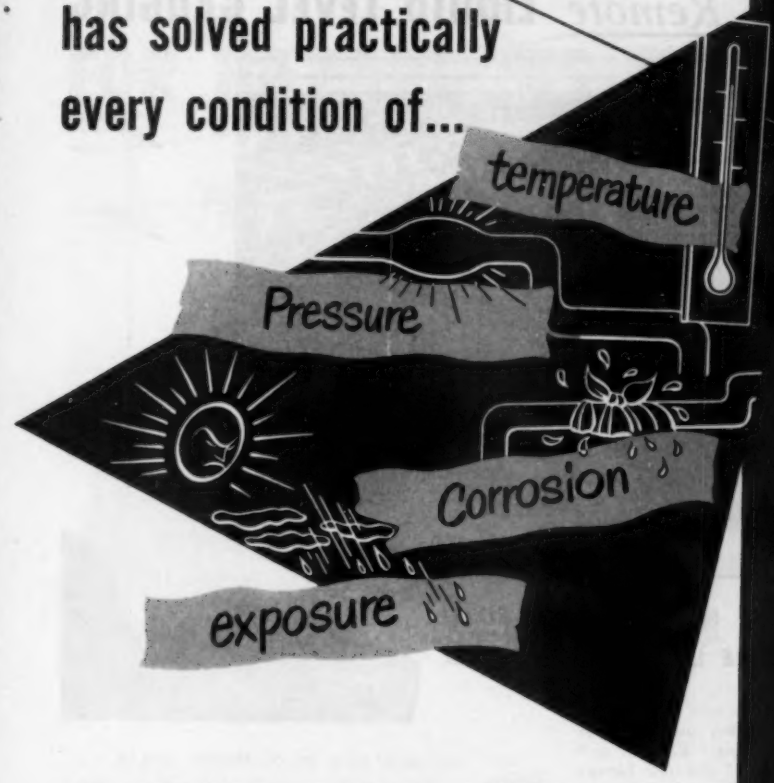
Aerofin is sold only by manufacturers of nationally advertised fan system apparatus. List on request.

AEROFIN CORPORATION

410 South Geddes St. SYRACUSE 1, N. Y.

NEW YORK • BOSTON • CHICAGO • CLEVELAND • DETROIT • PHILADELPHIA • DALLAS
SAN FRANCISCO • MONTREAL • TORONTO

One of these 27 different tubing analyses has solved practically every condition of...



- Low Carbon
- Low Carbon, ½ Mo
- Low Carbon, 1 Mo
- ½ Cr, ½ Mo
- 1 Cr, ½ Mo
- 1¼ Cr, ½ Mo
- 2 Cr, ½ Mo
- 2¼ Cr, 1 Mo
- 2½ Cr, ½ Mo, ¾ Si
- 3 Cr, ½ Mo, 1¼ Si
- 3 Cr, 1 Mo
- 5 Cr, ½ Mo
- 5 Cr, ½ Mo, 1½ Si
- 5 Cr, ½ Mo, Ti
- 6 Cr, ½ Mo
- 7 Cr, ½ Mo
- 8 Cr, 1 Mo
- 9 Cr, ½ Mo
- 9 Cr, 1 Mo
- 12 Cr, Al
- 17 Cr
- 27 Cr
- 18-8
- 18-8 Ti
- 18-8 Cb
- 18-8 Mo
- 25-20

● Here at Tubing Headquarters, we have long maintained a razor-sharp staff of specialists—men with many years of experience in solving refinery tubing problems.

These specialists have had a tremendous file of data to help them. Some of it came from our own laboratories. But the most valuable data came from actual case histories . . . and constant observation of refineries throughout the country.

To cope with numerous problems, we developed 27 different analyses that we frankly think have helped to solve almost any refinery tubing problem. We've watched these tubes in service—and we've seen them do a good job.

When you plan for future projects bring your tubing questions to National Tube Company. Most of the time, a problem that is new to you will be a simple matter of recorded history to us. All of this bed-rock experience is yours for the asking. We will be glad to help you.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.

(TUBING SPECIALTIES DIVISION)

COLUMBIA STEEL COMPANY, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS

UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

NATIONAL SEAMLESS PIPE AND TUBES

UNITED STATES STEEL

Now... NUMBER OF TANKS AND DISTANCE Unlimited

ACCURATE *Remote* LIQUID LEVEL GAUGING

Fig. No. 850R Electronic Gauger Transmitter installed with "VAREC" Fig. No. 253 Automatic Tank Gauge.

"VAREC" Field Telephone Link Transmitter.

Fig. No. 801 "VAREC" Electronic Gauge Receiver.

. . . WITH THE NEW "VAREC" FIELD TELEPHONE LINK TRANSMITTER

Now, with "Varec's" unique new Field Telephone Link Transmitter, (when used in conjunction with its Electronic Gauger Receiver and Electronic Gauger Transmitter) distance factors are literally unlimited, as are the number of tanks possible to gauge from a single remote point.

At the turn of a dial switch, accurate, **REMOTE** liquid level gauging in oil refineries, chemical plants, pipe line pump stations and storage terminals is an important reality.

Utilization of existing telephone or power lines minimize installation and wiring costs, in addition to material savings realized in time, labor and accurate gauging with a "Varec" Electronic Gauger installation.

Now it is possible for only one gauger or operator to obtain accurate (within ⅛") continuous gauge readings from any one or a series of tanks simultaneously. The operator needs no special electronic knowledge to maintain or service the "Varec" unit as all parts are of standard plug-in design.

A complete extra service kit is included to assure continuous, dependable operation. WESTON Meter equipped. Low voltage, low current transmission only 0.001 volts D.C. at explosion-proof tank transmitter. Designed to operate from 110-115 volt, 50-60 cycle A.C. or 220 A.C. power at receiver.

There's a "Varec" Electronic **REMOTE** Liquid Level Gauging unit to meet your requirements. Where close control of blending operations is desired, automatic high and low valve, pump and alarm control is available. Write for our recommendations on your gauging problems today.

FOR ALL TYPES OF TANKS — FOR SINGLE OR MULTIPLE INSTALLATIONS • 4 TYPES OF "VAREC" EXPLOSION-PROOF TRANSMITTERS TO MEET WORKING PRESSURES UP TO 300 PSIG • ELECTRONIC OR MECHANICAL HI-LO LEVEL ALARM SYSTEMS.

PROVED and APPROVED "Varec"

THE VAPOR RECOVERY SYSTEMS COMPANY

COMPTON, CALIFORNIA, U. S. A.

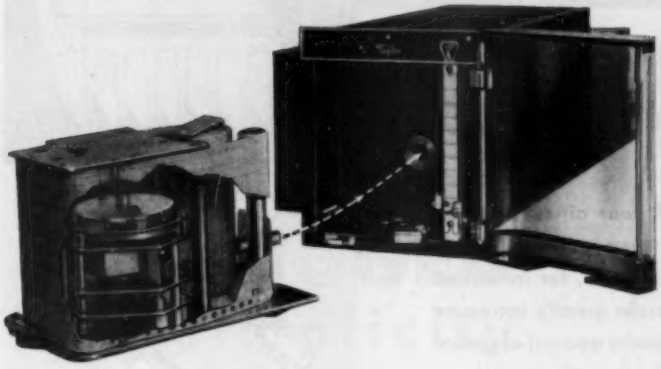
Cable Address: VAREC COMPTON USA (All Codes)

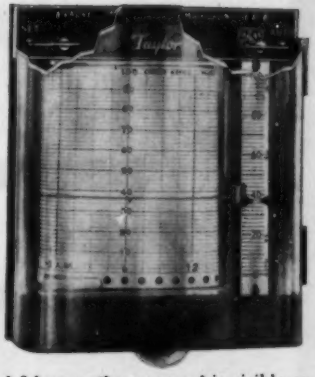
New York – Boston – Pittsburgh – Chicago – Detroit – St. Louis – Houston
Tulsa – Casper, Wyo. – Provo, Utah – Los Angeles – San Francisco – Seattle

P-18

PNEUMATIC CHART DRIVE FOR HAZARDOUS ATMOSPHERES

on Taylor's TRANSET Recorder*





A 3-hour continuous record is visible on this thirty-day rectilinear strip chart. This TRANSET Recorder fits 4⅜" x 5" panel space, with automatic-manual unit, remote set point adjustment, valve position indicator—all with unmatched accuracy and dependability.

Another Taylor Hit! The air driven chart drive mechanism for the popular TRANSET RECORDER makes all the advantages of the recorder available to installations in hazardous atmospheres. No electrical connections. The air jet turbine is geared to a self-starting escapement. The pneumatic chart drive is precision-built to give performance that equals or betters spring actuated clock mechanisms.

Accurate, Trouble-free performance is assured because the escapement mechanism is sealed in a rugged, air-tight, rust-proof housing mounted above the air jet out of the air stream.

Low Air Consumption! Only .08 scfm at 20 psi. Operates accurately even though air supply fluctuates within 15 and 35 psi.

Minor timing adjustments can be made externally, and the whole unit may be removed from the chart assembly by removing just three screws. Self-sealing air connection shuts off air supply automatically when chart drive is removed.

For Complete Details, send for Bulletin 98097-A.

Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

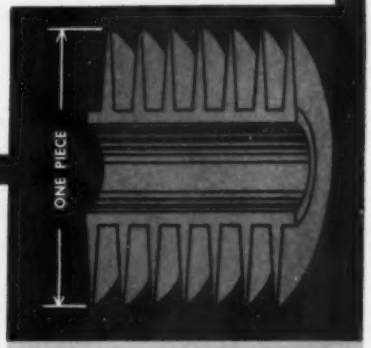
Instruments for indicating, recording and controlling temperature, pressure, humidity, flow and liquid level.

Taylor's Centennial — ACCURACY FIRST — SINCE 1851

Taylor Instruments
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

*Trade-Mark

Here's one CERTAIN way you can increase the capacity of your air-cooled condensers



Install WOLVERINE TRUFIN*

You can multiply the capacity of your air-cooled condensers at least twice—sometimes even more—than that of plain tube units of the same size. And, for increased efficiency, the use of Wolverine Trufin greatly increases the condensing surface area in the same amount of space!

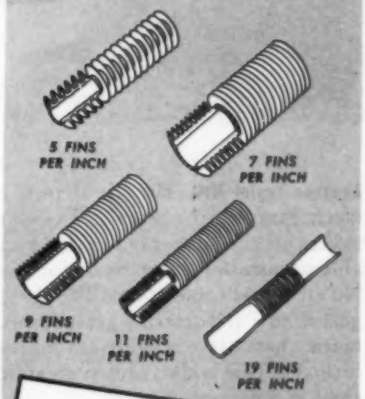
Operational troubles are minimized, too, because the fins of Trufin are extruded from the tube itself. With the fins integral to the tube, they easily stand vibrations and extreme temperature changes.

Yes, Trufin is the answer to many condensing tube problems where you need the utmost in efficient performance. WOLVERINE TUBE DIVISION, Calumet & Hecla Consolidated Copper Company, Incorporated, *Manufacturers of Seamless, Non-Ferrous Tubing,* 1431 CENTRAL AVENUE, DETROIT 9, MICHIGAN.

*Reg. U. S. Pat. Off.

Wolverine Trufin and the Wolverine Spun End Process available in Canada through the Unifin Tube Co., London, Ont.

Trufin is available in many sizes, alloys, and fin spacings in both single metal and bi-metal tubes.



A request on your stationery will bring you Bulletin giving helpful information regarding the use of finned tube in air-cooled condensers. Would you like a copy?

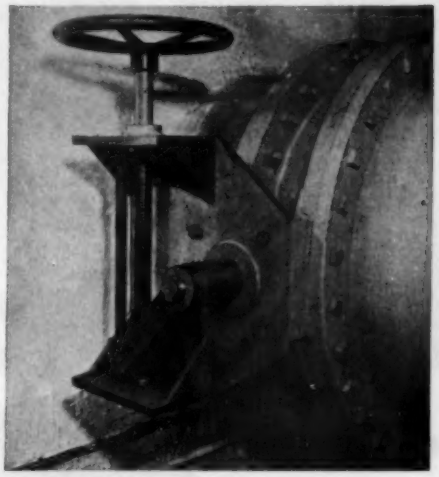
Wolverine Condenser Tubes stocked by Butler Industries, Inc., 355 South Fourth Street, Beaumont, Texas. Tel.: Beaumont 5-2351.

PLANTS IN DETROIT, MICHIGAN AND DECATUR, ALABAMA
Sales Offices in Principal Cities

Export Department, 13 E. 40th St., New York 16, N. Y.

R-S valvEvents

• EXCERPTS FROM THE R-S BOOK OF EXPERIENCE •



RUGGED Simplicity

Correctly engineered mechanically and metallurgically, all body assemblies of R-S Valves equal or exceed A. S. A. standards in every detail. These valves are designed and constructed for rugged service and provided with such safety factors that they will exceed service expectations as well as reduce pumping and blower costs.

Consider also the few working parts, greater control rangeability, the self-cleaning feature and the fact that R-S Valves are readily adapted to automatic operation. Know the rugged simplicity of R-S Valves, and get the most from your valve investment.

District offices are listed in telephone directories as, "R-S Products Corp'n Valves".

R-S PRODUCTS CORPORATION
4600 Germantown Avenue, Philadelphia 44, Pa.
An S. Morgan Smith Company Subsidiary

No. 782—Heavy Duty Rubber Seated Wafer Type Valve with 5° angle seated vane and enclosed gear reduction drive. Gland can be removed and stuffing box repacked without removing prime mover.

No. 739-740—Sixty-inch, 50-pound Heavy Duty Valve with gear reduction drive and handwheel for handling water at 40 psig. Vertical valve stem enclosed in steel pipe support. Thrust bearing absorbs vertical load.

No. 730—R-S Heavy Duty Floor Stand for rugged service in connection with any standard R-S handwheel operated valve.

No. 767—A 3-Way Valve (Two 24-inch 125-pound Cast Iron Valves bolted to 125-pound American Standard Tee). Electric motor operated by cross linkage. Automatic declutching handwheel for emergency operation.

Mobilization Message

...from a heat exchanger

Has fugitive efficiency left you holding a bag full of "maybe's"?

This clad steel equipment says you can do better. It says that hide-and-seek efficiency can be caught, the "gamble" engineered out of your plant . . . by the creative techniques of a capable equipment builder.

For builders like this look beyond your specifications to the actual needs of your project. Resourceful design and fabrication are your assurance of peak performance . . . economically achieved.

And Lukenomics sews it up tight . . . adding to fabricators' talents the extra skill of the engineer and designer, as well as Lukens' knowledge of materials, their production and use.

We know quite a few builders like this. Write today, stating your problem, for some of their names. Manager, Marketing Service, Lukens Steel Company, 404 Lukens Building, Coatesville, Pa.

Promote steel production generally—speed sale of your scrap.

Fabricated by an equipment builder using the Lukenomics principle.

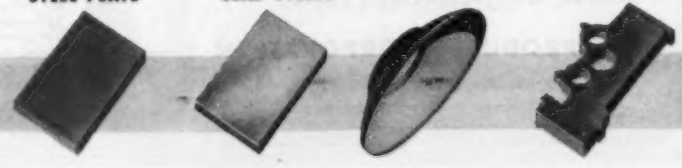
Equipment used in refining naphtha from sour crudes was put out of action every 6 weeks. Corrosion was the enemy . . . and to lick it, a smart equipment builder designed and fabricated modern coolers and heat exchangers with shells and tube sheets of Lukens Monel-Clad Steel. RESULTS: Trouble-free, more profitable operation . . . despite high pressure attack by phenol, hydrogen sulfide, and sulfurous acids. And by using *clad* steel, the equipment builder cut costs, effected important savings in a critical metal. *This is Lukenomics at work.*

LUKENS

LUKENS STEEL COMPANY

OVER 140 YEARS' EXPERIENCE AS THE WORLD'S LEADING PRODUCER OF SPECIALTY STEEL PRODUCTS

STEEL PLATE | CLAD STEELS | HEADS | STEEL PLATE SHAPES



10 HOUDRIFLOW

UNITS IN OPERATION

With ten HOUDRIFLOW catalytic cracking units now operating—some for more than a year—the advantages of the process have been conclusively demonstrated.

- ✓ Lowest investment
- ✓ Minimum operating cost
- ✓ Highest product yields
- ✓ Low catalyst consumption
- ✓ Proven operation on all types catalysts
- ✓ Maximum operating flexibility
- ✓ Lowest maintenance requirements
- ✓ Efficient technical service
- ✓ Matchless experience from 80 Houdry licensed units since 1936

Consult us when considering Catalytic cracking

HOUDRY CATALYTIC PROCESSES

SERVING THE PROGRESSIVE PETROLEUM INDUSTRY

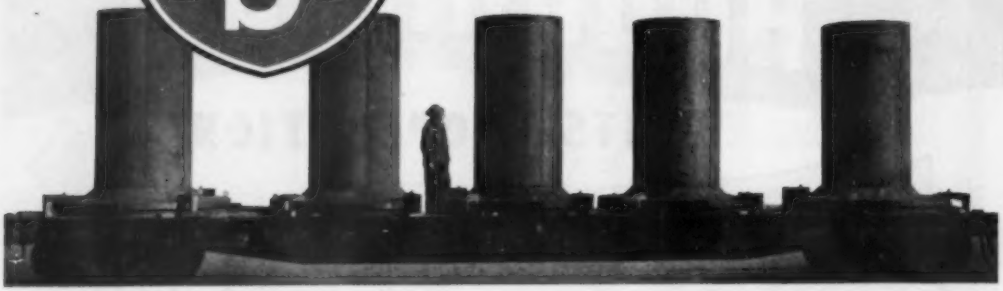
HOUDRY PROCESS CORPORATION PHILADELPHIA 2, PA.

The PRESSED STEEL CO.

PSC

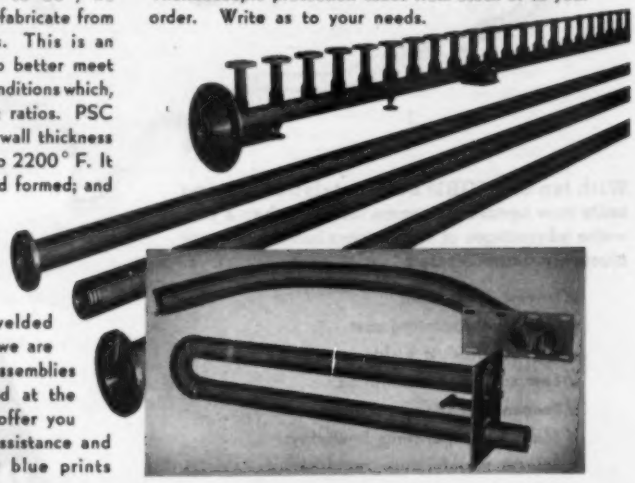
Specialists in

BIG ALLOY TUBING



IN ANY ALLOY *to Meet Your Specific Heat or Corrosion Problem*

As suppliers of welded alloy refining equipment for almost 25 years, Pressed Steel Co. offers you a wealth of experience in fabricating welded alloy tubing. Furnishing any diameter up to 60", we specialize in the larger diameters. We fabricate from the complete list of available alloys. This is an advantage that enables PSC tubing to better meet particular heat, corrosion or oxidation conditions which, in turn, is resulting in better life/cost ratios. PSC welded alloy tubing is furnished in any wall thickness from 1/16" to 3/8"; temperatures up to 2200° F. It can be readily bent, coiled, swaged and formed; and butt-welded to make any required length. Chemical and physical perfection of PSC tubing is assured by hydrostatic, tolerance, surface and straightness tests. Thermocouple protection tubes from stock or to your order. Write as to your needs.



Tube Assemblies Fabricated to Your Blue Prints, in Any Metal

As one of the largest suppliers of welded alloy tubing to the process industries, we are called upon to custom-fabricate tube assemblies for every imaginable purpose. Pictured at the right are some typical examples. We offer you a wealth of experienced engineering assistance and production know-how. Send your blue prints

THE PRESSED STEEL COMPANY

of WILKES-BARRE, PENNSYLVANIA

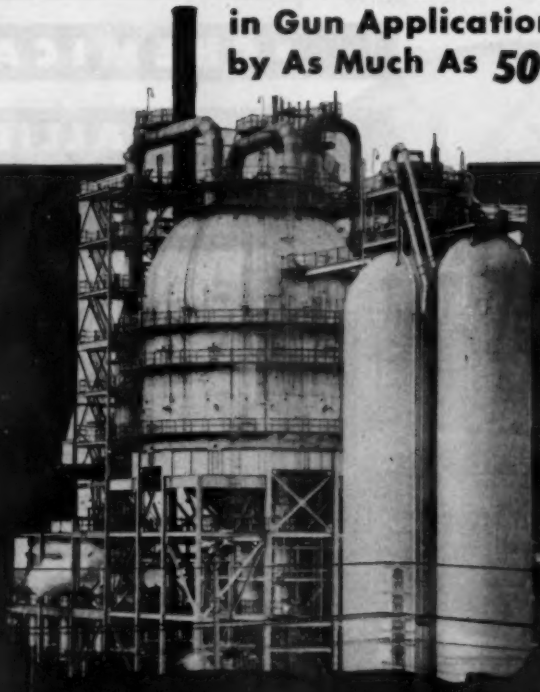
Industrial Equipment of Heat and Corrosion Resistant WEIGHT-SAVING *Sheet Alloys*

☆ ☆ ☆ OFFICES IN PRINCIPAL CITIES ☆ ☆ ☆

A. P. Green
REFRACTORY
PRODUCTS

Castable Refractories
SK-7 and KS-4

Reduce Rebound Loss in Gun Application by As Much As 50%



DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD

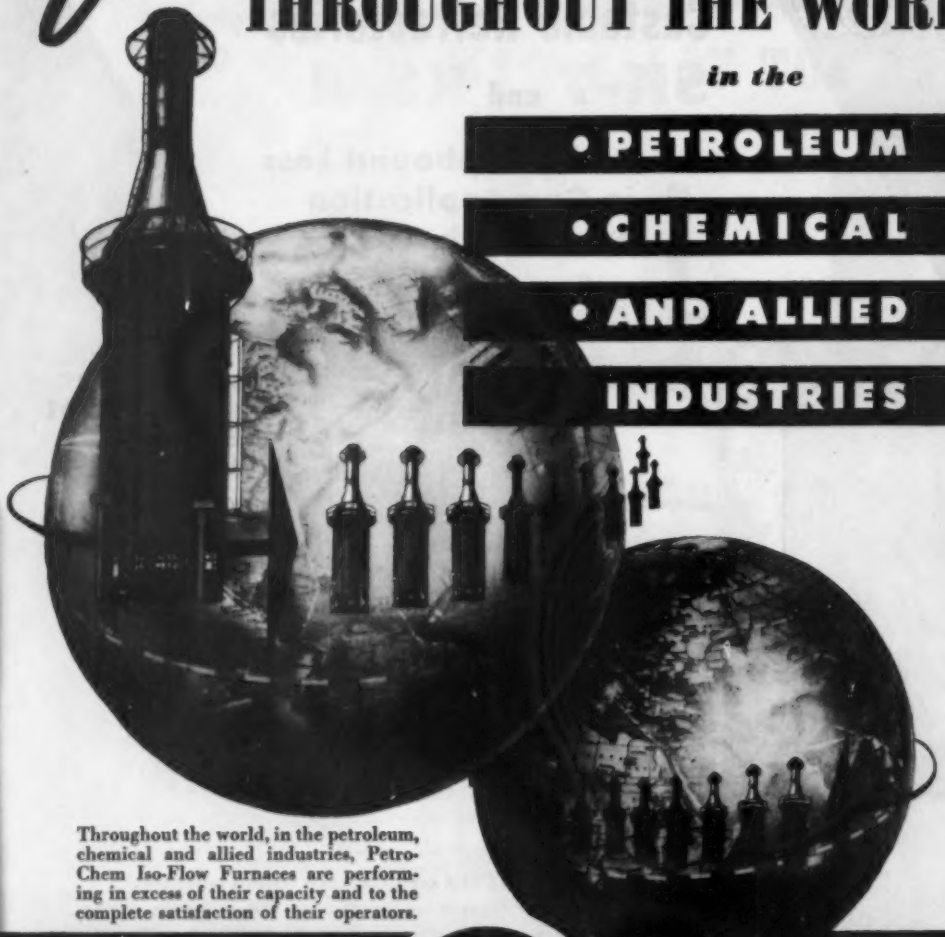
PETRO-CHEM ISO-FLOW FURNACES

favored

THROUGHOUT THE WORLD

in the

- PETROLEUM
- CHEMICAL
- AND ALLIED
- INDUSTRIES



Throughout the world, in the petroleum, chemical and allied industries, Petro-Chem Iso-Flow Furnaces are performing in excess of their capacity and to the complete satisfaction of their operators.

PETRO CHEM

ISO-FLOW FURNACES

UNLIMITED IN SIZE . . CAPACITY . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC., 120 EAST 41ST STREET, NEW YORK 17, N.Y.

REPRESENTATIVES

Bethlehem Supply, Tulsa and Houston · Flagg, Brackett & Durgin, Boston · D. D. Foster, Pittsburgh

Faville-Levally, Chicago · Lester Oberholz, California · Gordon D. Hardin, Louisville, Kentucky

"What competition is there among major oil companies?"

Harry F. Wood, attorney of Olympia, Washington, writes: *"What type of competition does actually exist among the major oil companies? Price? Service? Research? If it's research, we should find one company's brand of oil, for example, gives better engine protection."*

Harry F. Wood

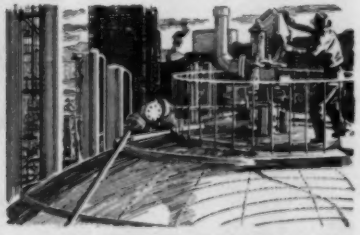
The answer to this question is much the same for the oil industry as for most others. Competition is intense in *all* operations. In oil, operations may be grouped under four broad headings...

I'd Like to Know...

You may have heard that a suit has been filed by the Antitrust Division in Washington to break up Standard of California as well as six other big oil companies which are in business on the West Coast. Already hundreds of people have written us protesting this action. Many have asked pertinent questions. We believe we should answer these questions for everyone. And we take this way of doing so. If you have a question, we urge you to write us at this address:

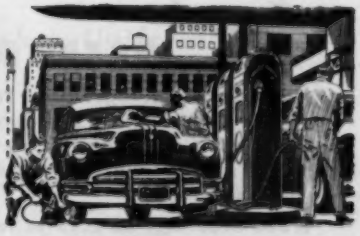
"I'd Like to Know"
225 Bush Street
San Francisco 20

Competition starts in production, getting crude out of the ground. Oil companies (both large and small) first explore, then bid for rights to land where oil may exist. Competition in efficiency then begins. Ways must be found to make wells produce at costs low enough to meet market prices.



Competition continues in refining. Again each company must make the operation pay. A plant must produce products as good as or better than those of other refiners, at prices as low as theirs or lower. No company can keep customers with products either not good enough or too expensive.

Competition in research exists indeed. That's why *two* gallons of today's gasoline, for example, do the work that took *three* a generation ago. A company must keep pace or lose out. As for differences between brands of oil: atomic energy is now being used to measure engine wear as it occurs. It reveals our new motor oil reduces wear as much as one-half, as compared with conventional oils.



And competition shows up clearly where our products are *sold*. This does, in part, take the form of *service*. (Wherever you find Chevron gasolines, you find a man making good on our promise, "We take better care of your car.") But it's also competition in *price*. To get and hold business, every seller must maintain quality in products and service, and hold his prices down to meet others.

STANDARD OIL COMPANY OF CALIFORNIA

• plans ahead to serve you better

FISHER®

Teflon*

V-RING PACKING CONVERSI KIT

A *Complete*

PACKAGED UNIT

This complete packaged Fisher Teflon V-Ring Conversion Kit converts a standard Fisher stuffing box unit to Fisher Teflon V-Ring Packing. It offers prompt service, guarantees a true fit and insures damage-free delivery.

When ordering, be sure to furnish the valve serial number found stamped on the patent plate attached to yoke or body.

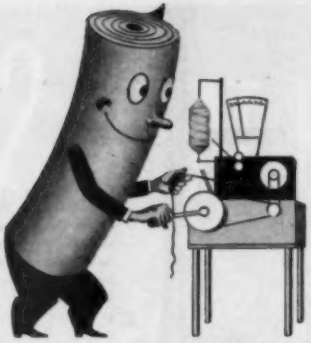
* Teflon is the trade name of E. I. DuPont de Nemours & Co.

Fisher Teflon V-Ring Packing is furnished as standard on new Fisher Diaphragm Motor Valves.

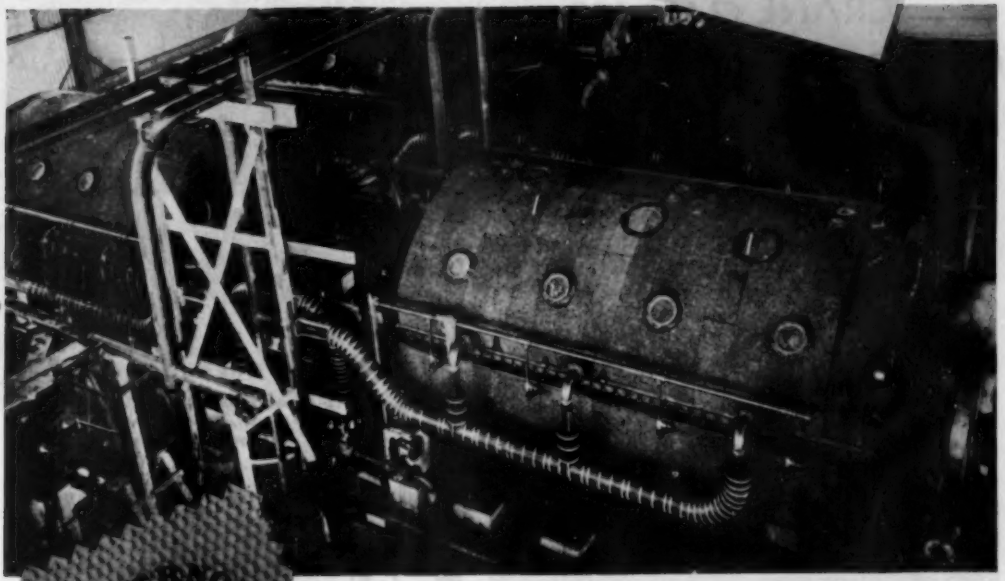
FISHER GOVERNOR COMPANY
Marshalltown, Iowa

FISHER

WORLD LEADER IN THE MANUFACTURE OF PRESSURE REGULATORS AND IN RESEARCH FOR BETTER PRESSURE CONTROL



UNIFORMITY
Makes the Big Difference in FILTER Fabrics



Gives You Greater Fabric Uniformity

The greater uniformity of Mt. Vernon Extra means more efficient filtering — greater clarification of filtrates, more complete recovery of solids.

AT YOUR SERVICE

Mt. Vernon-Woodberry's staff of textile engineers is available on request to help you with your problems in development or application of industrial fabrics.

CHECKING COEFFICIENT OF VARIATION And Average Factor Of Quality On Evenness In Roving With Beiger Tester. One of a series of comprehensive laboratory controls throughout production to assure uniformity in all Mt. Vernon-Woodberry products.

Mt. Vernon - Woodberry Mills

TURNER HALSEY COMPANY
Selling Agents
40 WORTH ST. NEW YORK

Branch Offices: Chicago • Atlanta • Baltimore
Boston • Los Angeles • Akron

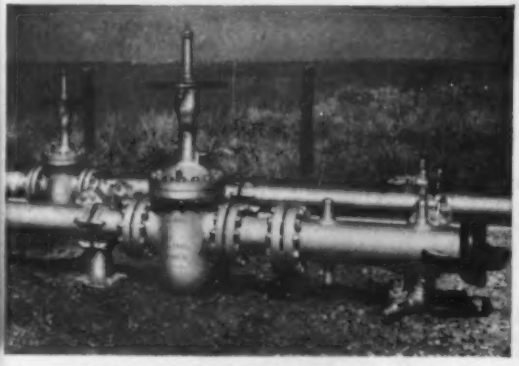
for smoother flow
easier operation
longer service life

...CRANE *CLASS 600*
OIL AND GAS PIPE-LINE VALVES

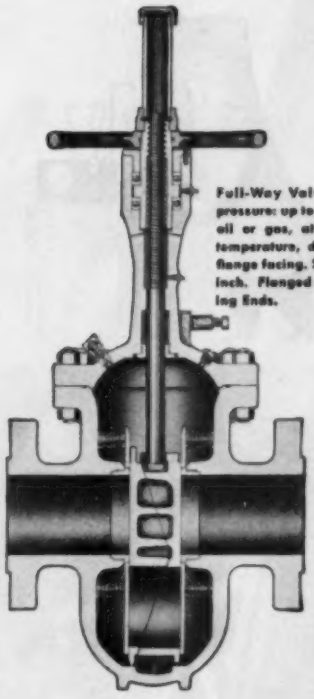
You get many advantages with these conduit-type, double-seating Crane Pipe-Line Gates. For example, smooth, full flow with minimum restriction . . . no turbulence. Circular disc ports—in perfect alignment with seat openings—eliminate pockets. This Crane design feature helps assure tight closure.

Grease packed body and bonnet assure easier valve operation . . . less maintenance. All working parts are lubricated to reduce friction and wear. And since Crane double-seating design seals off seating faces from line flow, seat erosion is eliminated.

For further information, see your Crane Representative or write for Circular AD-1864. No obligation.



Crane cast steel pipe-line gate valves on scraper trap in crude oil lines.



Full-Way Valve. Working pressure: up to 1440 pounds oil or gas, at atmospheric temperature, depending on flange facing. Sizes: 2 to 30-inch. Flanged or Butt-Welding Ends.

COMPLETE GREASE SEALING

Movable spring-loaded plates prevent grease entering line flow while valve is being operated . . . also close "conduit" openings in disc against entrance of grease.

In addition, plates wipe foreign matter and excess grease from disc faces and assist in guiding the disc. Readily accessible fitting in bonnet permits easy addition of grease when needed.

Venturi Type, available with flanged or butt-welding ends.

CRANE CO.

General Offices:
836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

2 GREAT PIPE INSULATIONS

Unibestos No. 750 - to 750° F.
Unibestos No. 1200 - to 1200° F.

Available in Cylinders or Half-rounds

UNIBESTOS®

. . . single-layer application saves money

When you can insulate a pipe efficiently with only one layer of covering, you save money. The range of thicknesses in which Unibestos Pipe Insulations are made permits the economies of single-layer application. Also a distinct saving in warehousing is made possible because fewer sizes of insulation are required in stock for maintenance work. But range of insulation thicknesses for single-layer application is only one of the many features of these 2 great pipe insulations—UNIBESTOS No. 750 and No. 1200. Write today for catalog giving complete information.*

UNARCO

UNION ASBESTOS & RUBBER COMPANY

DEPT. 1823 • 332 SOUTH MICHIGAN AVENUE • CHICAGO 4, ILLINOIS

**New 8-page catalog (No. 76-109) "UNARCO Insulations • Asbestos Packings • Gaskets • Textiles"*

DEMPSTER DUMPSTER SYSTEM

SERVING COST-MINDED MANAGEMENT FROM COAST TO COAST

. . . handling bulk materials of every description at phenomenal savings

Photos show the three simple stages of servicing a container. The Dempster-Dumpster, operated from hydraulic controls by driver in the cab, picks up each container and hauls it to point of disposition where it may be dumped or set down intact.

ALCOA

-recognized across the nation

. . . Aluminum Company of America, well known for sound management, uses the Dempster-Dumpster System

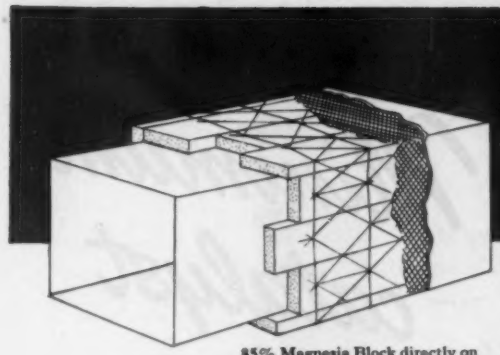
Aluminum Company of America is among the hundreds of cost minded manufacturers, both large and small, using the Dempster-Dumpster System of bulk materials handling . . . the system recognized across the nation for its efficiency and ability to reduce costs.

In the Dempster-Dumpster System one truck-mounted Dempster-Dumpster eliminates up to 10 conventional trucks because one Dempster-Dumpster services a great number of Dempster-Dumpster containers. These detachable containers, ranging in size up to 12 cu. yds., carry pay-loads equal to and greater than conventional truck bodies. They are built in a wide variety of designs best suited to handle any type of materials, be they bulky, light or heavy . . . solids or liquids . . . trash or rubbish. Containers are spotted at necessary materials accumulation points inside and outside buildings. The Dempster-Dumpster services one pre-loaded container after another.

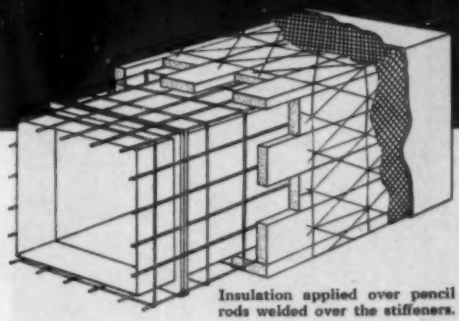
In addition to saving thousands of dollars annually in tires, gas, oil, and truck maintenance, the Dempster-Dumpster System eliminates standing idle time by truck and crews . . . eliminates handling and re-handling of materials . . . and increases efficiency and cleanliness. It will pay you to investigate the Dempster-Dumpster System now! A product of Dempster Brothers, Inc.

One Dempster-Dumpster Services All Containers. . . All Designs. . . All Sizes

DEMPSTER BROTHERS, 571 Dempster Bldg., Knoxville 17, Tennessee



85% Magnesia Block directly on surface of the metal breeching.



Insulation applied over pencil rods welded over the stiffeners.

WE HAVE BEEN ASKED:

"Is it necessary to have an air space between a metal breeching and the 85% Magnesia Block covering it?"

A letter we received a short time ago posed this question—"A metal breeching recently put up in our power plant carries gases at temperatures between 500° F. and 550° F. from our boiler to the economizer. We are going to cover the breeching with 3" 85% Magnesia Block. Would you advise leaving an air space between the insulation and the breeching to prevent heat from scaling or disintegrating the metal?"

Our answer pointed out that recent studies have proved that an air space makes little difference in the temperature of the metal. The design of the breeching is the thing that determines whether or not an air space is recommended. If breechings are free of exterior stiffeners, expansion joints, and other raised parts, the Magnesia block can be applied directly to the metal, wired in place, and finished with insulating cement. However, this condition usually exists only on very short runs or moderate temperature ducts.

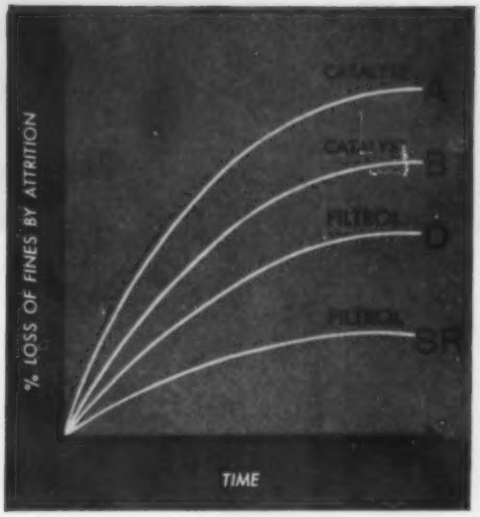
If the breeching has expansion joints or stiffeners, V-ribbed metal lath or pencil rods should be welded across the raised parts to provide a flat surface for the insulation.

This method spreads expansion and contraction evenly along the entire length of the breeching and guards against the appearance of unsightly cracks in the plaster finish.

When you have a problem involving insulating materials and insulation methods, call on Armstrong for advice. Over the years, our nation-wide contracting organization has discovered the right answers to just about any insulation problem. Remember, too, that this nation-wide organization offers you a complete insulation service, including good materials and trained construction men to apply them.

SEND US YOUR QUESTIONS: If you have any questions on the use or application of either high- or low-temperature insulation, please do not hesitate to write us. We'll do our best to give you a practical answer. Just address a letter or post card to Armstrong Cork Company, Heat Insulation Dept., 7507 Maple Avenue, Lancaster, Pennsylvania.

ARMSTRONG'S INDUSTRIAL INSULATIONS



Minimum catalyst attrition

FILTROL* S R FLUID CRACKING CATALYST SHOWS MINIMUM FORMATION OF 0 TO 20 MICRONS FRACTION IN USE: STACK LOSSES ARE LOWER AND CATALYST MAKEUP IS MORE EFFECTIVE. THE END RESULT IS IMPROVED CATALYST SELECTIVITY WITH ITS ATTENDANT ADVANTAGES.

OTHER
REASONS FOR USING
FILTROL CATALYSTS

1. HIGHER OCTANE BARRELS
2. HIGH BUTYLENE YIELD
3. LOW COST
4. SULPHUR RESISTANT CATALYSTS
5. FASTER REGENERATION RATE
6. VARIED PLANT FACILITIES
7. TECHNICAL SERVICE
8. UNIFORMITY
9. LOWERED EXCESS BUTANE

FILTROL CORPORATION

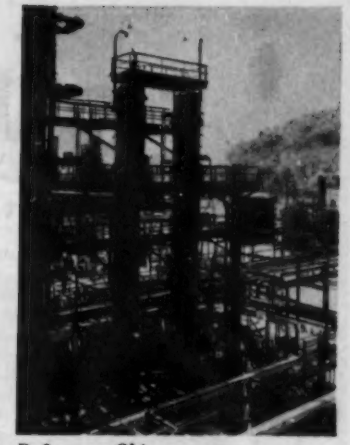
OFFICES: 727 WEST SEVENTH ST., LOS ANGELES 17, CALIFORNIA
PLANTS: VERNON, CALIF.; SALT LAKE CITY, UTAH; JACKSON, MISS.

Filtrol CATALYSTS AND ADSORBENTS

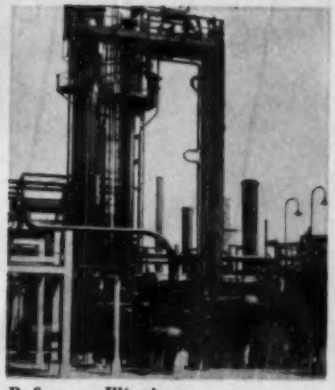
* T. M. Reg. U. S. Pat. Off.

Chemical Plant...Texas

Works speak louder than words



Refinery...Ohio



Refinery... Illinois

Chemical Plant...Arkansas

They all use **Girdler GIRBOTOL Plants** to remove acid gases

YOU CAN COUNT on Girdler's wide experience in building GIRBOTOL plants to keep right on growing. For the GIRBOTOL process is the *most economical method known* for removing acid gases, such as hydrogen sulphide and carbon dioxide from gas mixtures. More and more companies are proving that to their own satisfaction with operating data from their GIRBOTOL plants.

The GIRBOTOL Process is the *accepted* process for purifying gaseous refinery hydrocarbons. And more than a score of GIRBOTOL plants are being used to remove hydrogen sulphide from liquid hydrocarbons such as butane, propane, poly-feed stocks, straight-run naphthas and gasoline.

You'll find the GIRBOTOL Process not only the lowest cost method of hydrocarbon purification, but it may also be a source of valuable by-product hydrogen sulphide, used to produce elemental sulphur.

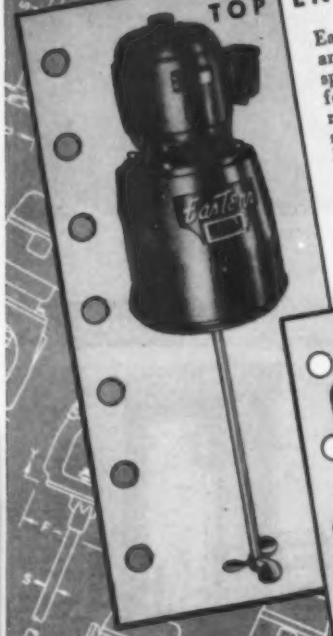
You can obtain technical help from Girdler on problems involving the manufacture, purification, separation, or utilization of industrial gases. Call or write now. The Girdler Corporation, Gas Processes Div., Louisville 1, Ky.

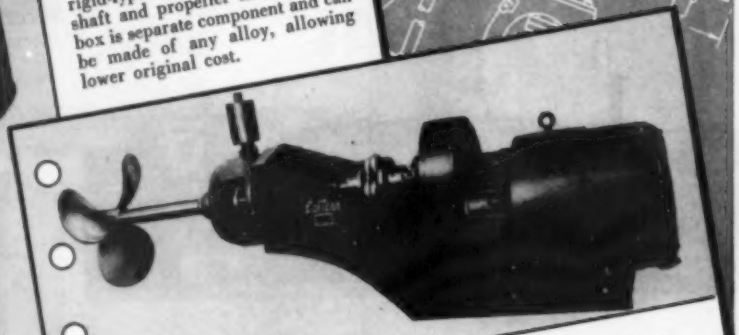
THE GIRDLER CORPORATION
Gas Processes Division

EQUIPMENT NOTES

TOP ENTERING MIXERS

Eastern Series C Vertical Mixers are applicable to a wide variety of specialized needs. They're designed for tanks needing agitators with a range of 1/4 to 10 H.P. at standard speeds of 1725, 1140, 420 and 280 R.P.M. They have standard NEMA ball-bearing type motor with a rigid-type coupling between motor shaft and propeller shaft. Stuffing box is separate component and can be made of any alloy, allowing lower original cost.





HEAVY-DUTY SIDE ENTERING MIXERS

Eastern Series A Mixers are extra heavy-duty machines for large tank capacity. They range from 5—30 H.P. at standard speeds of 1150, 420, and 280 R.P.M. Shaft is coupled to standard motor by flexible coupling, and the shaft and bearing housing move as single unit to allow easy adjustment and repair. Stuffing box is repackable with full tank.

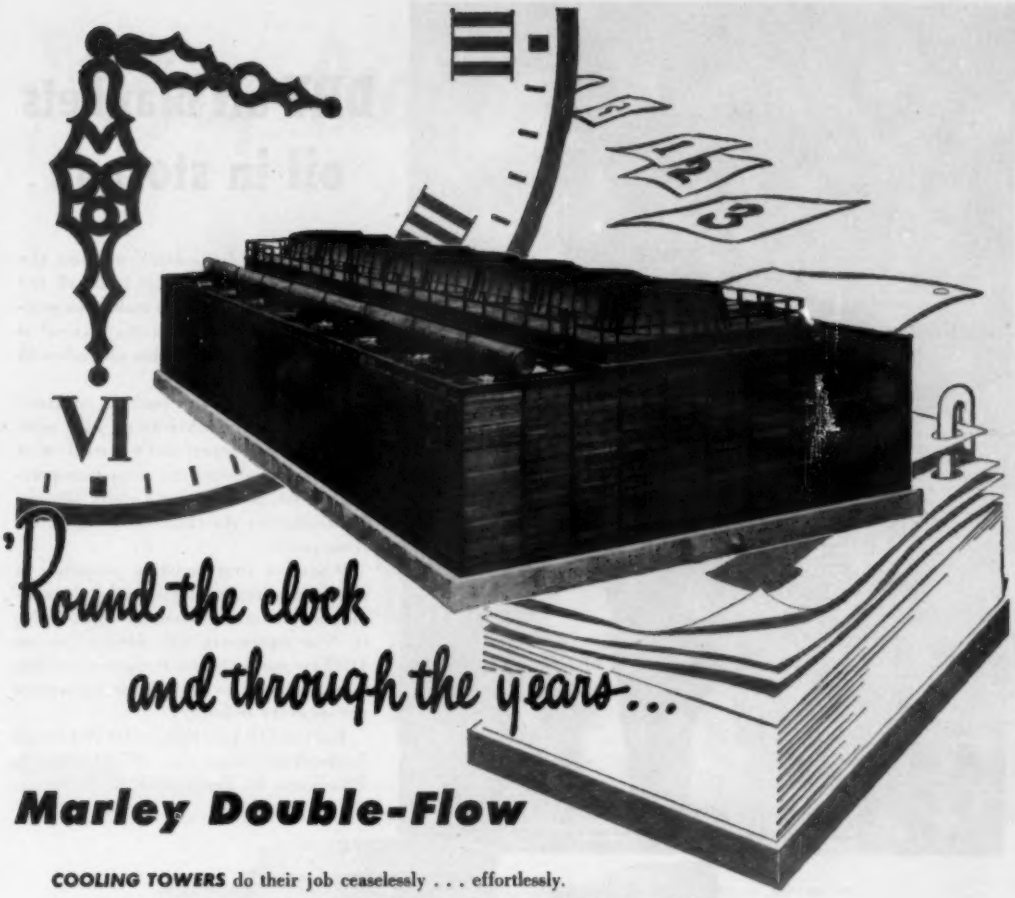
Eastern

Catalog sent on request . . .

The complete Eastern catalog of Fixed Mounting Mixers, both Top and Side Entering, is yours on request. Ask for Bulletin TC-600.

EASTERN INDUSTRIES, INC.

NORWALK, CONN.



Marley Double-Flow

COOLING TOWERS do their job ceaselessly . . . effortlessly. Designed for long-service life, Double-Flow dependability is further assured by the patented design that makes possible "at-a-glance" inspection, on-the-spot maintenance—all without service shutdowns or lag in plant production.

The famous Marley open distribution system keeps the operator informed at all times on water conditions, and may be cleaned in minutes, during operation. By merely opening a door, the operator can walk through the entire tower, inspecting all essential parts as the Double-Flow continues to do its duty.

Marley fans, Geareducers, drive shafts—all designed for cooling tower service exclusively—are keyed to this same service simplicity. Mechanical equipment . . . distribution . . . filling . . . basin . . . from top to bottom and side to side, Double-Flow towers and *only* Double-Flow towers are an open book to the tower operator—a book that tells a story of ceaseless, effortless operation.

The Marley Company, Inc.
KANSAS CITY 15, KANSAS

MARLEY

DRY air blankets oil in storage

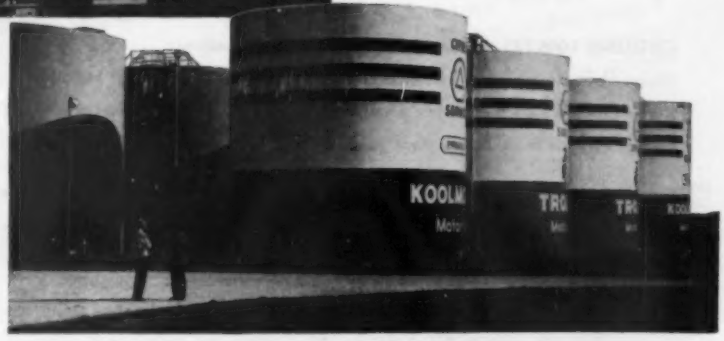
A Lectrodryer feeds DRY air into the manifold that distributes it to all the tanks. Automatic control maintains pressure on the manifold so that, as oil is drawn from the tanks, this air rushes in to take its place.

Thus Cities Service prevent contamination of their lubricating oils with moisture—a practice that's carried on at the refinery, aboard the ships transporting the oil, and here at Cicero, Illinois. Lectrodryers do that DRYing at all these points.

Whatever your moisture problem—in air, gases or organic liquids—there's probably a standard Lectrodryer able to solve it. Our engineers will advise you on DRYing methods and equipment, saving you time and money. Their experience covers every industry.

For this DRYing help, write Pittsburgh Lectrodryer Corporation, 307 32nd Street, Pittsburgh 30, Pennsylvania.

That manifold distributes DRY air to all the tanks in this Cities Service farm. The Lectrodryer that does this DRYing automatically is located in a small building right in the center of the tanks.



In England: Birlec, Limited, Tyburn Road, Erdington, Birmingham.
In Australia: Birlec, Limited, 51 Parramatta Road, Globe, Sydney.
In France: Stein et Roubaix, 24 Rue Erlanger, Paris XVI.
In Belgium: S. A. Belge Stein et Roubaix, 320 Rue de Meuse, Bressoux-Liege.

LECTRODRYERS DRY WITH ACTIVATED ALUMINAS

LECTRODRYER

REGISTERED TRADEMARK U.S. PAT. OFF.

● It is easy to understand why it took more than a rigger's version of "Geronimo" to set this giant propane tank "paratrooper"—and five more like it—snug aboard the S.S. Paolina . . . its 70'10" length would cover a strip on a big-league diamond from pitcher's slab to the end of the catcher's box, 10 feet behind the plate. Its 103" I.D. would allow a pitcher's full stretch . . . a batter's full swing.

Big-league delivery is an old Sun Ship custom. For more than 30 years its great plant has been making equipment for petroleum refineries—small tanks, fractionating towers, stills, pressure vessels, cracking cases, reactors, kilns, condensers, and machinery for all types of oil cracking and treating systems . . . And Sun Ship riggers have seen to it that they arrive . . . anywhere in the world . . . by ship, rail or truck . . . as ready for service as a paratrooper.

Sun

SHIPBUILDING & DRY DOCK COMPANY

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY

NO ROOM FOR "Trial and Error"

when you're buying VALVES

You're right the *first* time when you install Powell Valves

Powell makes valves precisely engineered to suit each and every industrial flow control service. Powell Engineers will be glad to help you select the *right* valves to meet your requirements.

Gate, Check, Globe and Y Valves, in Bronze, Iron, Steel and Corrosion-Resisting Metals and Alloys

Quality fine throughout "The Line"

Fig. 1793. Large 125-pound Iron Body, Bronze Mounted Gate Valve for low pressure steam, oil, water and gas services. Sizes 2" to 30", incl.

POWELL

The WM. POWELL CO., 2525 Spring Grove Ave., P. O. Box 106, Station B, Cincinnati 22, Ohio

MAXIMUM PERFORMANCE...

Getting "most of the salt" is not enough. In every installation Petreco engineers aim at 100% removal — and they're getting it, or closely approaching it, time after time. Some Petreco users now install desalters to treat crudes considered "comparatively salt free" only a few years ago. *Maximum salt removal permits top refining efficiency—you get PERFORMANCE with PETRECO.*

COMPETENT SERVICE...

Petreco engineers supervise construction on every installation. Petreco resident engineers are on 24-hour emergency call. Petreco research technicians and laboratory facilities are always ready to assist refiners on salt problems. Petreco engineers regularly inspect the desalting equipment and check its performance. Petreco warehouses replacement parts close to all major refining centers. *You get SERVICE with PETRECO.*

FAST PAY OUT...

One refiner states that Petreco Desalting "paid out" in *three months!* Another cited a *five months* payout. Payouts such as these represent substantial savings for any refiner charging salty crudes. The reasons most frequently cited for Petreco's fast payout are: Less plugging in crude furnaces, heat exchangers and reduced crude furnaces; less corrosion in topping units. *You get FAST PAY-OUT with PETRECO.*

OPERATIONAL FACTS...

If you have a desalting problem, ask Petreco for facts and figures—Petreco engineers can tell you why Petreco desalters deliver such high removal percentages, how Petreco Service is designed to help you, and why, how and where Petreco Desalters have more than paid their own way. *Get facts! They're available from*

PETROLITE CORPORATION
Petreco Division
3202 S. WAYSIDE DRIVE, HOUSTON 3, TEXAS
1390 E. BURNETT ST., LONG BEACH 6, CALIF.

PETRECO

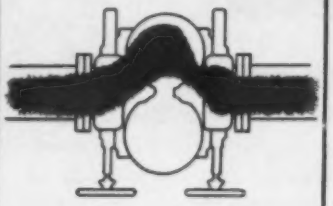
SPECIALIZED *Electric* PETROLEUM PROCESSES { DESALTING / DEHYDRATING

PR 50-2

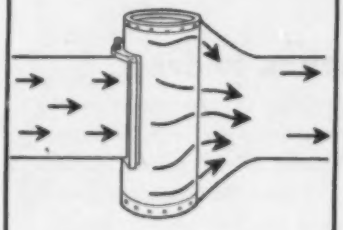
Why TWIN STRAINERS have exceptional life*

Other features of Twin Strainers...

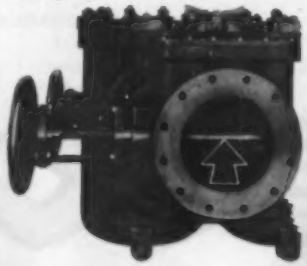
NON-STOP SERVICE
Sliding gate valve diverts flow from one chamber to the other when cleaning is necessary. No interruption of service.



LOW PRESSURE DROP
Large baskets and straight-through flow minimize pressure loss.



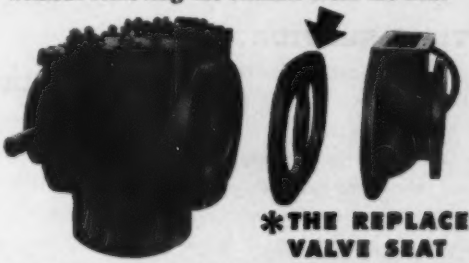
PROTECTED VALVE SCREW
Threads entirely covered and protected against exposure to liquid passing through.



This shows the rubber ring inserted in a slot in the disc. Operating as a gate valve, the disc cleans its own seat before finally closing.

*THE REPLACEABLE DISC RING

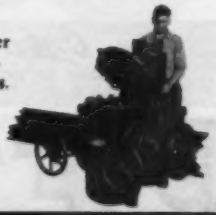
This is a Neoprene ring embedded in the face of the disc. It insures tightness and if after long use wear occurs, it can be inexpensively renewed. For this purpose the disc can be removed through the top of the strainer in a few minutes without removing the strainer from the line.



*THE REPLACEABLE VALVE SEAT

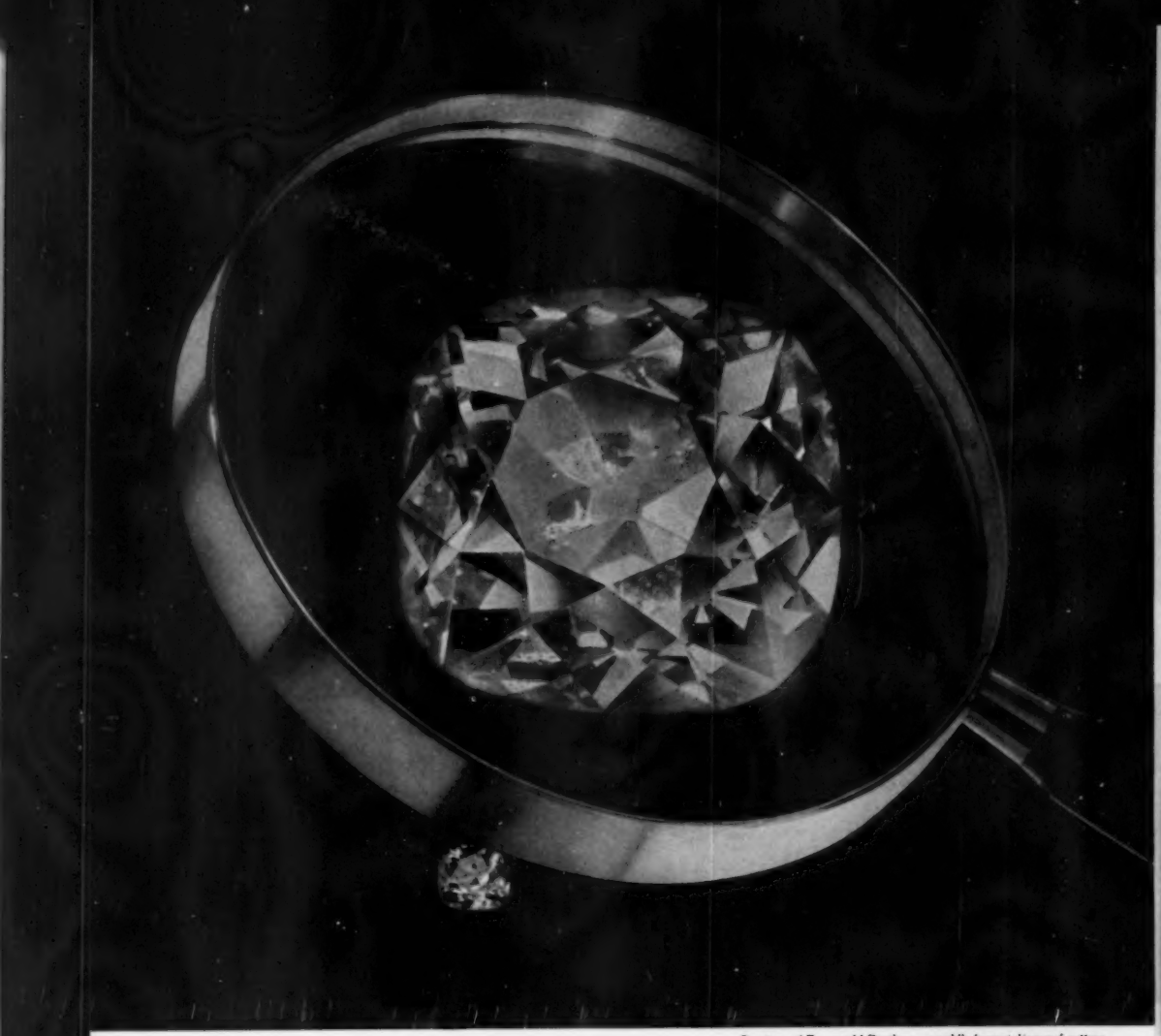
Where liquids are exceptionally corrosive, a valve seat or "wear plate" can be supplied which can be replaced with a new wear plate when wear or pitting occurs. Not required under usual conditions, but just one more factor in adapting Twin Strainers to any service.

Many thousands of Twin Strainers in power plants, process plants, ships, and all industries needing non-stop clearing of liquids, have long demonstrated their sound qualities. Now redesigned for even better performance and lower operating cost. You will want the details — Bulletin A-13 on request.



A-318

ELLIOTT COMPANY
Accessories Dept., JEANNETTE, PA.
Plants in JEANNETTE, PA. • RIDGWAY, PA.
AMPERE, N. J. • SPRINGFIELD, O. • NEWARK, N. J.



Courtesy of Baumgold Brothers—world's largest diamond cutters.

•

Why is complete antiknock service very much like a diamond?

•

WORTH-WHILE antiknock service, like a valuable diamond, has many facets... each of which must be perfectly formed in itself and properly related to the others.

It is Ethyl's twenty-seven years of experience concentrated in the antiknock field which has made possible the painstaking development of each individual facet.

Why is complete antiknock service very much like a diamond? *Continued from preceding page.*

Ethyl service follows every drop of "Ethyl" antiknock fluid all the way from its manufacture to its ultimate consumption in an engine.

"Ethyl" antiknock compound is mixed with gasoline—so we assist refiners in blending operations, offer a wide variety of technical aids and, through national advertising, help them sell leaded gasoline. Since this gasoline is used in engines, a continuous fuel-engine research program is constantly in progress. Finally, because these engines are used in many types of vehicles—cars, trucks, buses, tractors, airplanes—special Ethyl activities have been developed in each specialized field.

Each of these services is a facet on the Ethyl service diamond—important individually, but whose true worth can be measured only in terms of the entire program.

ETHYL CORPORATION
NEW YORK 17, NEW YORK

Experience

is the most important ingredient in "Ethyl" antiknock fluid

• RESEARCH

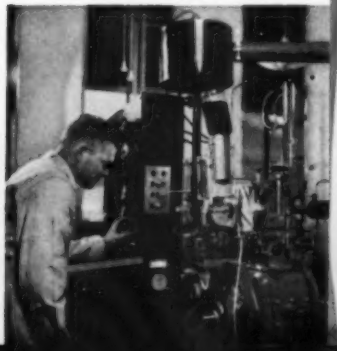
• FARM SERVICE

• SAFETY SERVICE

• SALES HELPS

• ROAD TESTING

• GASOLINE TESTING



This STUD Saves You Money

The stud shown above is the Bethlehem Continuous-Thread Tap-End Stud. Put it to work where excessive strain and vibration are encountered, and it will save you money.

The Bethlehem Continuous-Thread Tap-End Stud is economical, even when used in the most difficult bolting jobs, because of the way it resists fatigue-failure. As the stud has no point of thread runout, the stress concentrations usually encountered are distributed over its entire working length, rather than being permitted to bunch up at any one point.

This stud also has two types of threads, making it ideal for installations requiring but one nut. The chamfered tap-end of the stud is threaded to Class 5 fit, and its rounded nut-end is threaded to either Class 2, 3, or 7 fit. Yet so expertly are the threads blended that we challenge you to detect the point where the change occurs.

The Bethlehem Continuous-Thread Tap-End Stud is made from carbon or alloy steel, and can be furnished heat-treated. It comes in diameters from ¼ in. to 1¼ in., and in virtually any length.

Put the Bethlehem Continuous-Thread Tap-End Stud to work, and you'll soon agree that it exceeds your highest expectations. If you'd like to have our representative call to discuss the stud in detail, please write to us at Bethlehem, Pa.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem-Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

Bethlehem supplies every type of Fastener

Lightnin Mixers

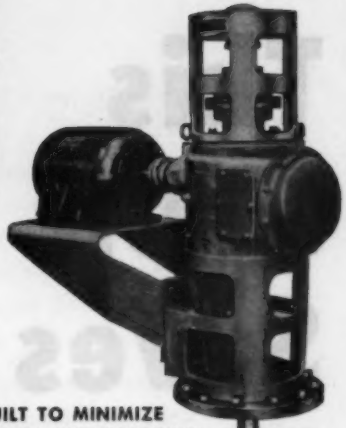
BUILT FOR THE YEARS AHEAD

We are straining every facility to meet the tremendous demand for Lightnin Mixers, greater than ever before in our history.

To insure that your fluid agitation will be just as efficient tomorrow, or ten years from now, as it is today, we are building every Lightnin Mixer to the same strict specifications as always.

Unfortunately, this means we must ask you to wait longer than usual for delivery. Our Materials Planning Department is actively engaged in anticipating your requirements so as to insure that there will be the least possible delay after your order is received. Check with us for latest delivery information.

The Lightnin Sales Engineer who services you will be glad to give you further information, and can suggest many ways to keep your present agitation equipment in service until the day your new Lightnin arrives. You will be glad you kept in touch with him.

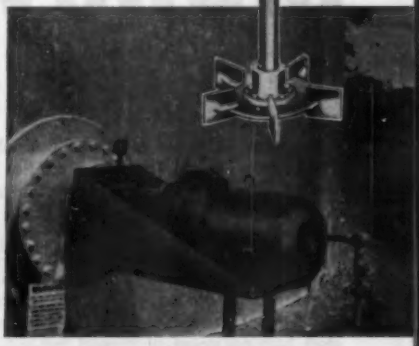


BUILT TO MINIMIZE MIXER OBSOLESCENCE

Lightnin Model TEC heavy duty turbine agitator is designed to meet changing process requirements. It is quickly convertible from closed tank to open tank service. Shaft may be extended upward for bottom entering use. Sixteen standard AGMA speeds are quickly available from the same heavy duty drive, all with standard 1750 RPM motor.

LIGHTNIN PORTABLE MIXERS are used universally in process industries. Many Lightnins have been in continuous service 20 years and more.

LIGHTNIN TOP ENTERING AGITATOR (Model TEC) in 2 HP size, installed in pilot plant for Streptomycin production. Development work benefits from Lightnin versatility.



LIGHTNIN SIDE ENTERING MIXERS are favored by petroleum refiners and other large-tank users. They are easily repacked from outside the tank, without draining the tank.

MIXING EQUIPMENT Co., Inc.
(MIXCO)
164 Mt. Read Blvd., Rochester 11, N. Y.
In Canada: William & J. G. Greey, Ltd., Toronto

Please send me the literature checked:

- ☐ B-76 Side Entering Mixers
- ☐ B-78 Top Entering Mixers (Propeller Type)
- ☐ B-89 Top Entering Mixers (Turbine and Paddle Type)
- ☐ DH-50 Laboratory Mixers
- ☐ B-52 Condensed Catalog showing complete line
- ☐ B-75 Portable Mixers (Electric and Air Driven)

Name_____

Title_____

Company_____

Address_____

City_____ Zone____ State_____

MAKERS OF

Lightnin® Mixers

LIGHTNIN PORTABLE MIXERS
World's largest-selling line. Electric or air motor, direct or gear drive. Sizes ⅛ to 3 HP.

LIGHTNIN SIDE ENTERING MIXERS
For tanks up to 5 million gallons. Gear motor or V-belt drive; exterior types. Sizes 1 to 25 HP.

LIGHTNIN TOP ENTERING AGITATORS
Turbine, propeller and paddle types. For open or closed tanks. 16 speeds available in new heavy duty drive. Sizes ⅛ to 300 HP.

A COMPLETE LINE . . . UNEXCELLED TECHNOLOGY

PETROLEUM REFINER

The LOOK BOX

WILLIAM L. BOLLES

Bolles Named Editorial Director

WILLIAM L. BOLLES, well known chemical and process engineer, who has been a regular contributor to these columns for some years past, on July 1 became editorial director of PETROLEUM REFINER.

This announcement was made late last month by Ray L. Dudley, publisher, and president of Gulf Publishing Company, who said that in the move the technical staff of the magazine would be greatly strengthened.

"We are delighted that Mr. Bolles has joined us and feel that it is definitely a move in the right direction," Mr. Dudley declared. "He is well versed in the processing field, has special talent along editorial lines, is aggressive and alert and we are satisfied our readers will soon note marked improvements as the result of his efforts."

Mr. Dudley indicated that further additions to the staff are in the making and said that full announcement will be made shortly.

Bolles has served as a process engineer at the Texas City plant of Monsanto Chemical Company for the last four years. His first post with them was in St. Louis, his home town, but he was sent to Texas City before long on the assignment of helping to re-design Monsanto's styrene plant which had been demolished in the April, 1947 explosion.

Prior to joining Monsanto, Bolles served four years on the staff of Socony Vacuum Oil Company, Inc., in the Field Research Department of Magnolia Petroleum Company, Dallas. Later he joined the company's Research and Development Laboratories, Paulsboro, N. J.

Bolles is a chemical engineering graduate with a B.S. degree from Washington University, St. Louis, and an M.S. degree from the University of Missouri.

His best remembered contribution to PETROLEUM REFINER probably is "Decimal Classification System for Chemical Engineering," which he compiled during a five-year period. Even before its publication in May, 1949, many of his fellow workers at Socony-Vacuum and Monsanto had adopted the system for their own use. Many reprints of the article have been furnished since it was published and in 1950 the Texas Library Association of Special Librarians adopted the system as he had outlined it.

Search Is on For Scrap Iron

LOW scrap iron stockpiles are again termed one of industry's vulnerable points. Company officials have been advised they must not only approve, but lead action to salvage all available scrap iron to supplement and build up available stockpiles. Inventories which have been fluctuating between days and weeks supply are warning signals which threaten critical shortages and industrial curtailment if not hastily rectified.

Under press of an emergency of unforeseeable length, the steel industry is committed to supplying steel for direct military uses, defense-related products, and also record quantities of consumer items. This can be done, but only if new steelmaking furnaces and those now being built are kept busy at all times.

The task of rebuilding depleted mill inventories of heavy scrap is a big one. However, previous scrap drives have been successful and we can benefit by earlier experiences with the problem. It is important that top administrative officials provide immediate assistance by locating production and dormant scrap and declaring it obsolete. It can then be sold as scrap and started on its way to steelmaking furnaces.

How long the present national scrap emergency

How DuPont services can help you gain extra efficiency and economy in use of additives.

Du Pont not only makes a complete line of gasoline additives, but also offers comprehensive technical services to help you use them most effectively.

Our District Laboratories, for example, are in a position to suggest ways of cutting your antioxidant treating costs. And, since gasolines vary in their response to different antioxidants, the laboratory recommendations are based on a thorough evaluation of your own stocks.

We are also prepared to assist in such problems as overcoming the adverse effects of copper in gasoline. Or, perhaps you would like help in training blending plant personnel, setting up a safety program, or supervising tank entries. At-the-plant assistance in such work is an important part of the Du Pont representative's job.

The Du Pont service program, which includes assistance in research and marketing as well as manufacturing, is described in detail in the booklet, "Du Pont Services to the Petroleum Industry." If you do not already have a copy, write to the nearest district office, or contact your Du Pont representative.

Make DuPont the Source for All Your Gasoline Additives

TETRAETHYL LEAD COMPOUNDS
(Motor Mix . . . Aviation Mix) Supplied with medical, safety and technical services.

GASOLINE ANTIOXIDANTS
(Nos. 5, 6 & 22) To meet a wide range of gasoline stabilization problems.

METAL DEACTIVATOR
Its metal deactivating properties result in reduced antioxidant treating costs.

GASOLINE DYES
(Red, Blue, Yellow, Orange) Uniform—and can be mixed to obtain a wide range of shades.

DU PONT
REG. U.S. PAT. OFF.

Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • Wilmington 98, Delaware

District Offices: New York, N. Y. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

IN CANADA: Canadian Industries Limited—Toronto, Ont.—Montreal, Que.

will last cannot be predicted. Current inventories must not only be increased to maintain production, but must be increased to a safe-working level to avoid a similar situation this winter when seasonal collections fall off.

Steel companies will need about 32.5 million tons of scrap, some 3.5 million tons more than required last year. Next year they will require over 35.5 million tons. It is important to remember that these additional tons of scrap do not have to be manufactured, they need only to be found and moved to the nearest scrap dealer.

The nation's steel mills need "Scrap for Steel for Defense." The challenge is obvious. Find it! Get it moving!

Does Might Make "Right"?

SPEAKING of recent action in Iran, events may prove that the Iranian government would have done better to "maintain" its sovereignty by accepting the responsibility of its contract with the Anglo-Iranian Company, than to have claimed its "rights" to nationalize.

Charles L. Harding, Socony-Vacuum Oil Company official, recently stated that the greatest hope a small nation has for its own survival is its ability to make valid and lasting agreements with large nations, and that a small nation which denies the sanctity of contracts is undermining a principle of international conduct which says the world shall not be ruled by force alone. To assert that the right of a sovereign power to nationalize is superior to its right to make a binding contract, he said, is pure sophistry —the legal equivalent of an irrestible force meeting an immovable object.

A government which acts under the name of nationalism to justify the abrogation of a legally binding contract has failed to recognize true legal concepts. In the same light, a small nation acting in this spirit has overlooked the main factor supporting its own sovereignty. "The right of a sovereign power to nationalize is one thing," Harding observed. "The responsibility of that sovereign power in fulfilling a contract binding on itself is another thing."

"If sovereign governments continue to abrogate contracts whenever it suits their purpose, there will be no basis for international commercial relationships," he continued. "In the world today we are endeavoring to adopt a higher order of conduct among nations. We are searching for a substitute for armed force that has so often governed in the past. We are contending," he said, "that the law of the jungle should no longer apply to problems arising among nations any more than it should apply to the problems arising among private persons."

If protests against such violations of these principles are not registered by the civilized world, international investment and trade required for the economic well-being of the people of the world will be inhibited. If private capital is to be invested abroad, some course of conduct to govern contractual relationships must be understood and accepted.

Public awareness of the Middle East and its importance to the United States and to freedom-loving countries outside the Russian orbit is growing, but loss of the area's oil to a numerically superior enemy "might tip the scales against us," according to Harding.

Iran is the one major oil field in the world not backed financially by American companies and, while American money is not directly involved, the principles of the case, as well as the fate of the industries and activities predicated on this supply of oil and affecting the lives and welfare of foreign peoples, compels our close attention.

Key to Sulphur Supply—Economics

THE key to the "whys" of current sulfur shortage is "economics" according to Langbourne M. Williams, Jr., president of Freeport Sulphur Company.

Just why is there a shortage of supply in the U. S. when our production has climbed to two and a half times prewar levels and effort is being put forth to boost output still further? Actually our supply of sulfur is more than ample to meet all the needs of American industry, but the serious shortage is occasioned by heavy demands of our allies who have practically brought their own production to a standstill. Why?

Brimstone from the salt dome deposits of the Gulf Coast, the major U. S. form, accounts for nearly half the world's sulfur output, but sulfur is obtainable from pyrites, sour natural gas, petroleum refinery gas, smelter gas and gypsum. Many foreign countries have such sources and prior to this period obtained their supply of sulfur from their own resources. At the present time, however, the free world is depending almost entirely on the U. S. product because it is so much cheaper.

World production of sulfur in 1950 was estimated at 11,700,000 tons. In the U. S. plans are already under way to start 3 new mining plants in Louisiana and Texas, as well as 13 additional projects to obtain sulfur from other sources. But the question remains, how long will our present sources hold out, and how successful will new mining ventures prove? Unless new and rich deposits of brimstone are discovered, the long term solution to the shortage must be achieved through further expansion of production from higher-cost sources of sulfur. Fortunately, Williams predicts that the nation's reserves of such sulfur are vast.

YES INDEED, refinery men *everywhere* know how good Lagonda 1100 Series Tube Cleaners are.

They know that the fully lubricated motor with ball thrust bearings at each end delivers smashing power to the cutter head with practically no friction loss, giving faster, more thorough tube cleaning—saving costly minutes and hours in getting stills back on stream.

They know the Lagonda is no 'rookie' at cracking tough tube cleaning jobs—for over fifty years it has been a 'veteran' in the never-ending battle against coke of all types.

Ask your friends in the industry about Lagonda, and for 'fact and figure' details write for Bulletin 29.

Better still (no pun intended) if you want quick action call for a representative. No obligation, of course.

IF IT'S TUBE CLEANING IT'S Lagonda

HALF CENTURY OF 1901 EC 1951 POWER PROGRESS

Y-301

ELLIOTT Company

LAGONDA DIVISION • SPRINGFIELD, OHIO

Plants at: JEANNETTE, PA. RIDGWAY, PA. • AMPERE, N. J. SPRINGFIELD, O. • NEWARK, N. J.
DISTRICT OFFICES IN PRINCIPAL CITIES

THE Middle of the Barrel Comes of Age

A. L. NICKERSON
Socony-Vacuum Oil Company, Inc., New York

IN A TALK before the annual meeting of the Independent Oil Men's Association of New England, held last month in Boston, A. L. Nickerson, director in charge of Domestic Marketing, Socony-Vacuum Oil Company, Inc., called the oil industry's attention to the need for shifting refinery yields from emphasis on gasoline production to that of the middle distillates. Portions of the talk relating expressly to jobbing problems, for instance, the need for having a substantial portion of the New England's winter fuel oil requirements in local storage by early November, are not presented in this abridged version which outlines in some detail the economic background of Mr. Nickerson's suggestion for emphasizing in refinery yields "the middle of the barrel."

LOOKING into the nationwide demand 10 years from now, we expect that consumption of the top of the barrel —gasoline and naphthas—will increase 37 percent over 1950. The demand on the middle of the barrel (which produces kerosine, range oil, heating oil, diesel fuel, and light gas oil) is estimated to increase by 43 percent. It appears that, despite increased competition for other fuels and barring an international catastrophe, you can expect consumer demand to continue upward, although at a somewhat reduced rate from the one that has prevailed.

Clearly, for these relative demands to be met, a fundamental change in refinery operations must occur. According to these estimates of demand, a continuation of present yields would produce either an over-supply of gasoline or a shortage of middle distillates. Therefore, the operation of the laws of supply and demand and price can be expected to effect some change in refinery operation in favor of the middle distillates. In other words, without committing ourselves to the extent of saying that distillates will tend to increase in price or gasoline to decrease, it is possible to express an opinion that the two products will tend to sell at prices somewhat closer than they generally have in the past.

The middle distillates have come of age and their demand now is such that they must compete with gasoline from the refiner's point of view. Their new status imposes certain responsibilities on the part of the three industry elements most interested in this group of products.

Let us consider briefly some of the responsibilities of the refiner. He is responsible for converting crude oil into products of adequate quality and sufficient quantity to meet the market demand. He must also bear part of the burden of providing adequate storage for them, although in order to avoid putting an impossible burden on transportation in the winter, much of the between-season storage should be located near the point of consumption.

Changed Trend

One matter relating to the problem of providing an adequate supply of distillates, deserves some attention. In the past, the demand for gasoline grew so rapidly and assumed such tremendous proportions that some refiners evidently have taken it for granted that refineries should be built and operated in such a way as to produce maximum gasoline all the time. During the period when octane ratings were fairly low and gasoline demand increased more rapidly than distillate demand, there was much to support this view. However, this trend has changed. Gasoline octane ratings have increased steadily, thereby increasing the cost of manufacturing this product, and the distillate demand curve has turned sharply upward and is expected to continue to rise at a rate somewhat above the rate for gasoline. In the light of these trends, it is suggested that the theory of refinery operation to produce the maximum amount of gasoline all the time may be wisely re-examined.

Realizing that the average United States refinery running on mixed Gulf Coast and Mid-Continent crudes possesses a good deal of operating flexibility, Socony-Vacuum Oil Company, Inc. became involved recently with a fairly complicated series of cost analyses to determine what relative price levels of regular gasoline and No. 2 heating oil at a refinery would tend to encourage a maximum yield of gasoline; at what relative price levels of these two products it will pay a refiner to begin to shift his yields in favor of middle distillates; and at what relative price levels it will pay a refiner to operate in a manner calculated to produce a maximum yield of middle distillates. The answers that have been developed to these provocative questions are preliminary, tentative, and obviously cannot be discussed here, but they suggest that any refiner who has not recently explored these questions can do so with benefit. Cost relationships in the petroleum industry rarely remain static for any considerable period of time.

There appear to be two things a refiner needs to assist him in meeting the future of distillate demand:

First, a series of cost analyses to determine at what price differentials between No. 2 heating oil and gasoline it will pay him to shift his yields in the direction of greater middle distillate production; and

Second, a narrowing in these existing differentials.

Narrowing Differentials

Under normal circumstances, we would confidently expect that the normal operation of the laws of economics would bring into being a price differential between No. 2 heating oil and gasoline that would establish a balance between supply and demand of these two products. However, since December 18, when the Office of Price Stabilization issued its initial request for a price freeze (subsequently replaced by OPS regulation 17), prices for all classes of trade have been frozen at levels which, at least in the case of refiners in the East and Gulf Coast areas, do not appear to encourage the production of the middle distillates. As the year progresses and as greater distillate production is needed to prepare for winter weather, it is to be hoped that OPS will recognize the potential danger in this situation and will take appropriate action.

Let us turn for a moment to the question of quality. The advent of higher octane gasolines and the necessity for a greater amount of more severe catalytic cracking has created a problem with respect to maintaining heating distillates at a satisfactory standard of stability because of the necessarily large quantity of cracked components blended with them. This situation achieved little notoriety outside industry circles, but the

It started with a V-crimp in Gaskets

In the new high-pressure, high-temperature power and processing plants, it is the spring-action of Flexitallic Spiral-Wound Gaskets that makes flanged joints effective. Prevents seepage caused by line strains, thermal shocks or vibration. Simplifies breaking and reassembly of joints. With pressures from vacuum to 2500 lbs. and with temperatures from -200° F. to 1800° F., the V-crimp construction of the Flexitallic Gasket results in a highly resilient seal and a low seating stress on the bolting. Properties of metal, type of filler, relationship of metal to filler—all these are variables in the design of a Flexitallic Gasket. Made for all standard joint assemblies in four thicknesses .125", .175", .250" and .285". Also available for special joint assemblies up to 104" diameter . . . Flexitallic Gasket Company, Eighth and Bailey Streets, Camden 2, New Jersey.

Flexitallic®

SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS, PROCESS EQUIPMENT

*Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket—look for *Flexitallic Blue* in gaskets with asbestos filler.

REPRESENTATIVES in principal cities (*indicates local stocks available): ***AMARILLO**—Moorlane Co.; **ATLANTA**—Boiler Equipment Service Co.; ***BALTIMORE**—Tate Engineering & Service Co., Inc.; **BOSTON**—G. H. Thomson; **BUFFALO**—Lane Engineering Co.; ***CHICAGO**—A. L. Crump & Co.; **CINCINNATI**—Gerlach; **CLEVELAND**—Illes Power Control Co.; ***DENVER**—Moorlane Co.; **DES MOINES**—Carl Grimes & Co.; **DETROIT**—Metrol Co.; ***HOUSTON**—Corbett Co.; Gulf Engineering Co., Inc.; Power Specialty Co.; **KALAMAZOO**—Metrol Co.; ***KANSAS CITY**—Moorlane Co.; ***LOS ANGELES**—Power Engineering & Equipment Co., Inc.; **MILWAUKEE**—A. R. Dietze; **MINNEAPOLIS**—Plant Equipment, Inc.; ***MOBILE**—Marine Specialty Co.; ***NEW ORLEANS**—Asbestos & Rubber Co.; **NEW YORK**—Consolidated Packing & Supply Co.; ***NORFOLK**—Empire Machinery & Supply Corp.; ***OKLAHOMA CITY**—Moorlane Co.; ***PHILADELPHIA**—Energy Control Corp.; **PITTSBURGH**—T. J. Barry; ***PORTLAND**—W. J. Robbins; **ST. LOUIS**—Lane Machinery Co., Inc.; ***SAN FRANCISCO**—Curdes Brothers; Transmission Engineering Co.; ***SAVANNAH**—Southern Marine Supply Co., Inc.; ***SEATTLE**—International Sales Corp.; **TOLEDO**—Metrol Co.; ***TULSA**—Moorlane Co.; **WICHITA**—Moorlane Co.; **WILMINGTON, DEL.**—Energy Control Corp.; **IN OTHER COUNTRIES**—***MONTREAL**—Tube Engineering & Service Co., Ltd.; ***VANCOUVER**—Fleck Bros., Ltd.; ***HONOLULU**—American Factors, Ltd.; ***MEXICO CITY**—Consultores y Representaciones, S.A.; **SAN JUAN**—F. R. Lluch Co.; **ROTTERDAM**—Van der Mark & Co.

gravity of the problem can be compared with engine detonation in the automobile of 20 years ago that, for a time, threatened to thwart the efforts of automotive engineers to increase the efficiency of automobile engines. This anology can be continued in that the additives Socony-Vacuum and other companies in the industry have developed to increase stability appear to have licked this tremendously important problem as surely and as effectively as tetraethyl lead contributed to licking the problem of engine detonation. In the absence of these new additives, more expensive treatment of heating oil stocks would have been necessary. Obviously, the refining segment of the industry must maintain the quality and reliability that have always characterized its products. It is one essential of trouble free automatic heating.

The primary supplier has much to worry him nowadays. He is faced with an increasingly difficult problem brought on by a fundamental characteristic of the heating oil business—its extremely seasonal nature. The distribution of our heating oil demand by months shows that 44 percent of our annual sales are concentrated in the months of December, January and February whereas only 11.5 percent are sold in the months of June, July and August. Diesel fuel, running counter to this trend, is of no material benefit in correcting it because diesel fuel represents only 20 percent of the total middle distillate fuels in the United States.

Most Vulnerable Spot

It is this characteristic that has tended to discourage many refiners from producing greater yields of distillate even when the economics of its production and sale may have been relatively attractive. In order to meet the peak seasonal demand for heating oils, 25 percent of the industry's annual production must be stored in expensive tanks during the previous summer and fall—in addition to what is consumed during the summer and fall. To reduce this peak seasonal inventory even a small amount requires radical shifts in refinery yields with consequent under-utilization of costly refinery equipment. If the refiner desires uniform monthly production, either he, the primary supplier, the reseller or the consumer must have in storage by early November one barrel of available inventory for each four barrels of annual light heating oil consumption. This one barrel in four figure is for the entire area east of the Rockies. The location of this inventory has an important bearing on the industry's transportation facilities. Most of these transportation facilities are strained to capacity during the winter months. This is the industry's most vulnerable spot.

Refinery and Other Plant Construction Notes

Petroleum Refiner's quarterly "boxscore" tabulation—nine pages—starts on page 77

ECA Approves Olefin Plant at Ferrara, Italy

An olefin plant estimated to cost over $18 million was approved by ECA for construction by the Montecatini Company at its Ferrara, Italy, site. The construction will be handled by the M. W. Kellogg Company.

Construction will consist of the olefin production unit and a chemical derivation unit, and will produce 10,000 metric tons a year of ethylene and a like amount of propylene, as well as minor quantities of butylene and liquid and gaseous byproducts. Various chemicals to be manufactured by the new plant include acetone, butadiene, styrene monomer, poly-ethylene and diacetone alcohol, among others.

The only other such European plant is in England. The plant is scheduled to go into operation in the summer of 1953.

Neodesha Plans Stepped-Up To Meet Increased Demand

Increased demands for petroleum products have caused Standard Oil Company (Indiana) to add a catalytic cracking unit and an alkylation unit at its Neodesha, Kans., plant even though original planning did not call for construction on these projects for a few years.

Work is already underway on the first half of the project which includes revamping and adding to the crude oil distillation, coking and rerunning units to increase the refinery crude oil capacity from 10,400 to 19,700 barrels a day. This project is scheduled for completion early next year while the cracking and alkylation units will not be completed until late 1952.

During the period between completion of the two steps of the over-all program, surplus cracking stock produced at Neodesha will be moved by pipe line to Standard's Sugar Creek, Mo., refinery for processing on the catalytic cracking facilities there.

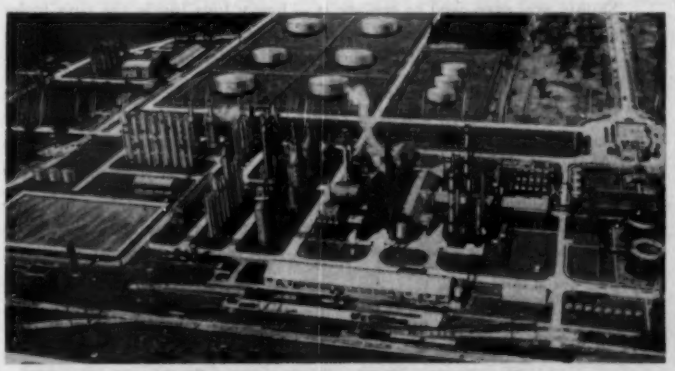
Shell Plans Petrochem Plant at Montreal East

Plans to build a $3 million petrochemical plant adjoining its Montreal East refinery were announced recently by Shell Oil Company of Canada, Ltd., with construction scheduled to start this summer and completion set the latter half of 1952.

Products will be Outaire isopropyl alcohol and acetone. It is estimated the plant will produce 20 million pounds of the two chemicals annually.

Acquire Process License

Richfield Oil Corporation and Sinclair Refining Company have acquired license permits to use The Atlantic Refining Company's new catalytic reforming process utilizing a platinum-containing catalyst. Richfield's initial application is expected to involve conversion of about 6000 barrels daily of closely fractionated feed stock to benzene and aviation gasoline aromatics



REFINERY TO TRIPLE OUTPUT—Above is an artist's conception of Continental Oil Company's Lake Charles, La., refinery after a $24 million expansion program is completed in 1952. Enlargement of the plant, which is under way, will increase capacity from 12,000 to 40,000 barrels of crude oil daily. Most of the facilities to be added are shown at the left of the picture. This includes in the extreme upper left the carbon black plant being constructed by Continental Oil Black Company, a corporation recently formed by Continental Oil Company and Continental Carbon Company.

Notice how the inner facing of the Lunkenheimer ring seats squarely against the body wall. There's no flange or shoulder where corrosion can work its way inside — no bending that causes leakage.

This end-seated Lunkenheimer ring *stays put* — won't warp out of place or twist away from the body as it is tightened. See how firmly the heavy ring seals itself into the wall, becoming an integral part of it, adding *extra* strength at the "nerve center," guarding against corrosion.

And this ring actually seats more tightly with years of wear.

Should you ever need to replace it — heavy lugs inside the ring make renewal simply a matter of screwing the old one out, the new one in . . . quickly, without serious production delays.

Before you approve that next order for steel valves in your plant, be sure to double-check seat ring construction. For longer life and lower maintenance costs, specify Lunkenheimer steel valves . . . with *shoulder-less* seat rings.

Write today for your copy of "Lunkenheimer Cast Steels," an informative 52-page brochure on the development and application of steel valve alloys. ***The Lunkenheimer Co., Box 360G, Cincinnati 14, Ohio.***

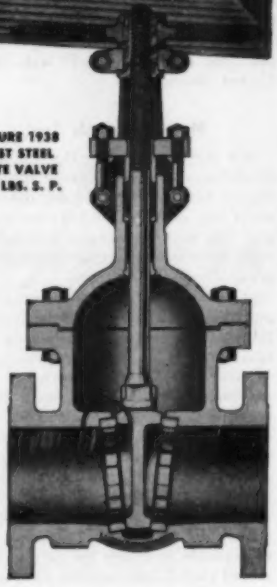


FIGURE 1938
CAST STEEL
GATE VALVE
300 LBS. S. P.

STEEL • IRON • BRONZE

LUNKENHEIMER

THE ONE *Great* NAME IN VALVES

L-401-5

concentrate. Sinclair is studying the economic aspect of installing a unit with a capacity level of approximately 20,000 barrels of gasoline.

Earl Gilmore to Build 50,000 BD Texas Refinery

Gilmore Refineries, Inc., backed by Earl Gilmore, veteran California oilman, and John Gostovich, is awaiting PAD certification to build a 50,000-barrel-a-day refinery in West Texas or New Mexico.

Initial cost of the project is said to be $25 million but may climb to $40 million, according to Gilmore. Finished products of the proposed refinery will be carried to Southern California by a 24-inch pipe line which will be built by Marc Leh and his partner, David E. Brown. The location of the refinery, probably Odessa, Texas, will depend on the pipe line route.

Foster Wheeler Gets Esso 9500-Barrel Everett Units

The general contract for expansion and modernization of Esso Standard Oil Company's refinery at Everett, Mass., has been awarded to Foster Wheeler Corporation with construction scheduled for September. Units will include a 18,500-barrel-a-day fluid cat cracker, a 7000-barrel rerun pipe still, a gas compression plant, and a light ends plant among other facilities which will increase capacity by about 9500 barrels, to a total capacity of 42,000. Engineering for the project will be handled by Standard Oil Development Company.

Foster Wheeler was recently given the general contract to build the 10,000-barrel refinery for Standard Vacuum at its Durban, South African plant. A crew has been dispatched to commence field survey work.

Foster Wheeler Awarded Durban Refinery Contract

Foster Wheeler has been named general contractor for the new 10,000-barrel crude refinery to be constructed at Durban, Union of South Africa, for Standard Vacuum Refining Company of South Africa, Ltd. An advance party of construction engineering experts from Foster Wheeler headquarters in New York is expected to begin field survey work sometime this month.

Foster Wheeler is also contractor for the Fawley, England, refinery which is considered Europe's largest.

Marcus Hook Plant Gets New Houdriforming Process

Houdry Process Corporation has completed arrangements for the installation of a Houdriforming unit at Sun Oil Company's Marcus Hook, Pa., refinery. The Houdriformer will have a charging capacity of 11,000 barrels of naphtha per calendar day and will operate in conjunction with the new Sun Arosorb process for aromatics purification. The Arosorb process will produce more than 13 million gallons per year of chemical grade benzene, 30 million gallons of toluene, and 15 million gallons of aromatic aviation gasoline blending stock for the production of grade 115/145 aviation fuel.

Engineering is in progress and the project is scheduled to go on stream in the Fall of 1952.

Important feature of the Houdriforming process is the catalyst which is fabricated from commercially available materials and has specific properties for the high conversion of petroleum naphthas into benzene, toluene, and xylene. The catalyst is capable of long continuous operation without regeneration, but can be regenerated in place for operating flexibility.

Houdry officials believe the Houdriforming process will help alleviate shortages of benzene, toluene, aromatic hydrocarbons and xylene, and will contribute to aviation gasoline supply. It can also be used to produce high yields of high octane motor fuels. Low-octane mixed-base straight-run naphtha processed in pilot plant runs by the Houdry Laboratories produced a gasoline having a 98 research octane number without tetraethyl lead, with a yield of 86 volume percent gasoline of ten pounds Reid vapor pressure. With the addition of tetraethyl lead, the product has a research octane number well over 100 according to Houdry reports.

Houdry plans to license the process to other refiners and offers a generalized cost estimate of about $3 million for a 10,000 barrel-a-day plant.

Ethylene Glycol Project

Latest projects reported certified by PAD for rapid tax amortization are Hancock Oil Company's $4 million California plant for production of ethylene glycol, and that of Mathieson Chemical Corporation in Baltimore for production of liquid chlorine used in manufacture of tetraethyl lead and in treatment of refining cooling waters. They received 60 and 50 percent certification respectively.

Braun Erects Sweeny Unit

Construction of the 30,000-barrel crude distillation unit to be erected at the

Construction

Sweeny, Texas, refinery for Phillips Oil Company, was awarded to C. F. Braun & Company. Scheduled for completion by October 1, 1951, the unit will increase the refinery capacity to 67,000 barrels. PAD granted fast tax amortization of 85 percent for the distillation unit which is estimated to cost around $4.8 million and for a $3,630,200 aviation alkylate project with a capacity of 1800 barrels.

Wood River Chemical Plant Construction to Begin

Construction on the isooctyl alcohol plant being built for Standard Oil Company (Indiana) at Wood River, Ill., is expected to start this month and be completed by late 1952. It is designed for the annual production of 10 million pounds of isooctyl alcohol.

Indoil Chemical Company, a Standard Oil subsidiary organized to handle chemical products, will handle sales of alcohol from the new plant.

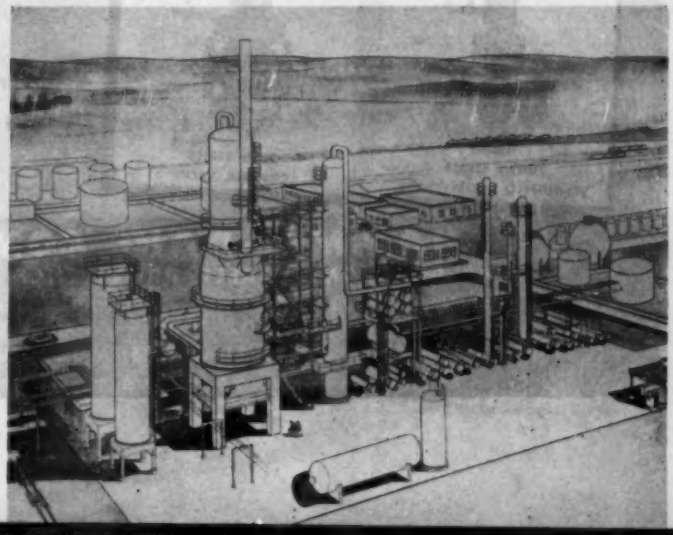
Big Spring Contracts Made

Contracts have been let for Cosden Petroleum Corporation's Big Spring BTX unit for the production of benzene, toluene and zylene. The $3 million project will be built by Procon, Inc., while Universal Oil Products will handle the engineering. Units consist of a platforming unit and related facilities. Ground preparation will commence about August 1. Feed stock will be the refinery's present yield of straight-run gasoline.

Add to Nitrogen Capacity

A $25 million project to expand synthetic nitrogen capacity by 100,000 tons annually has been announced by Allied Chemical & Dye Corporation's Solvay Process Division for its plants at Hope-

ORTHOFLOW FLUID CRACKER—Construction is almost 50 percent completed on this new Orthoflow Fluid catalytic cracker for Cities Service Oil Company at its Ponca City, Okla., refinery, according to The M. W. Kellogg Company, New York, which designed the unit. The cracker, which will charge 8300 barrels daily, is part of a general modernization program at this refinery. New facilities at Ponca City, aside from the cracker, will include a gas recovery plant, designed and engineered by Kellogg. Utilities and yard facilities are being expanded to meet the process requirements of the new equipment.



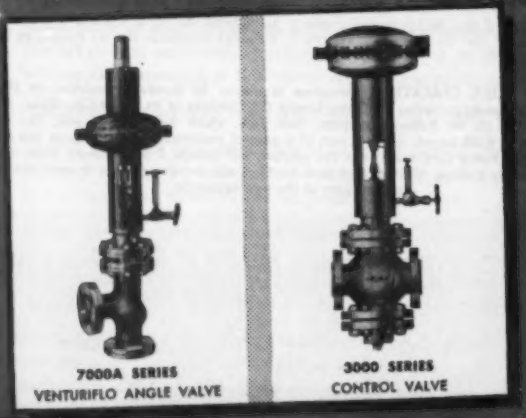
AUTOMATIC CONTROL EQUIPMENT

ENGINEERED DESIGN BY **HAMMEL-DAHL**

This special test panel in Shell Development Company's Instrumentation Laboratory, provides accurately controlled pressures, flow rates and electrical equivalents for testing and evaluating control devices.

7000 SERIES MICROFLO CONTROL VALVE

Whatever the problems of control— Leaders of Industry turn to . . .



7000A SERIES VENTURIFLO ANGLE VALVE

3000 SERIES CONTROL VALVE

HAMMEL-DAHL

Whether it's precise control of minute flows in a laboratory or pilot plant

or

accurate control of the most difficult production process.

HAMMEL-DAHL COMPANY

243 RICHMOND STREET, PROVIDENCE 3, R. I., U.S.A.

ALBANY BOSTON BUFFALO CHICAGO CINCINNATI CLEVELAND DETROIT HOUSTON KALAMAZOO KANSAS CITY KINGSPORT, TENN. LOS ANGELES NEW ORLEANS NEW YORK PITTSBURGH SAN FRANCISCO SEATTLE ST. LOUIS SYRACUSE TOLEDO TULSA WILMINGTON, DEL.

In Canada, Railway & Power Engineering Corporation, Ltd.

well, Va., and South Point, Ohio. The project is to include facilities for extracting hydrogen from natural gas. Since 1946, the aggregate annual nitrogen capacity of the two plants has been expanded by 80,000 tons.

Brazil Will Duplicate Successful Oil Refinery

Plans to duplicate Brazil's first complete refinery on the Mataripe River on Salvador Bay in Dahia State are underway. The original refinery is a 2500 barrel-a-day plant designed and constructed by The M. W. Kellogg Company in conjunction with its Latin American subsidiary, Kellogg Pan American Corporation, and the staff of Conselho Nacional do Petroleo, Brazil's independent government agency created to explore and develop Petroleum resources. The refinery went on stream last September and is served by crude oil mix containing 80 percent crude obtained through a six-inch pipe line from the Candeias producing field two miles distant, and 20 percent crude supplied by barge from Itaparica Island, 14 miles away in Salvador Bay. The pipe line has to be steam heated because of the high pour point of the Candeias crude which is approximately 95° F.

The second refinery will carry the 2500-barrel capacity of the original combination topping and thermal cracking plant and will also have facilities for catalytic polymerization and LPG production from the combined gases of the total 5000-barrel operation. Kellogg has contracted to install the second refinery.

California Cat Underway

Construction on a thermal cracking plant and related facilities were underway this month at the Bakersfield, Calif., site of the Sunland Refining Corporation refinery. Cracking capacity will reach 900 barrels daily when the construction is completed in November. The project is being engineered by Universal Oil Products while the Sunland staff will handle construction.

Wilshire Plant at Norwalk Nears Early Completion

Construction at the Wilshire Oil Company of California refinery at Norwalk is nearly complete this month with only final details of the company's largest expansion and modernization program to be attended to. Petroleum Maintenance Company of Long Beach, contractor for the project, completed the conversion of a U.O.P. catalytic polymerization unit to a high-pressure polymerization unit; reconditioned and modernized a fluid catalytic cracking unit which had been shut down since 1946; converted an operating two-coil 25,000-barrel Dubbs thermal cracking plant to a single-coil unit with the light oil heater included in a new vacuum unit installed to produce feed stock for the cracker.

The new vacuum unit was completed in 34 days and went into operation in May.

Fluid Hydroformer Under Construction at Destrehan

The first fluid hydroformer for commercial operation will be built for Pan-Am Southern Corporation at Destrehan, La., by The M. W. Kellogg Company. The unit will have a feed capacity of 2000 barrels per stream day and has been designed with such process flexibility as to be usable for a variety of purposes and rates.

Hydroforming utilizes catalysts to increase the octane number of straight-run gasoline and to convert certain naturally occurring materials into aromatics, notably benzene and toluene. The new, improved process applies for the first time to hydroforming the fluidized technique of making solids "flow" that is utilized so widely in catalytic cracking. With this process, operating costs are reported to be lower, and product improvement is gained.

Wide variations in feed stocks is permitted with the process, in particular, naphthas of wide boiling range, including those of less than average naphthene content and blends containing up to 25 percent of cracked stocks can be upgraded, while octane numbers of 95 and upwards can be obtained.

Features of the Destrehan units were developed by Standard Oil Development Company, The M. W. Kellogg Company, and Standard Oil Company (Indiana).

El Paso Alkylation Plant Contract Awarded Kellogg

Contract for the design and construction of a sulfuric acid alkylation plant to be erected for Standard Oil Company of Texas at El Paso has been awarded The M. W. Kellogg Company at a figure estimated to be upwards of $1 million. Kellogg reports the plant will employ a cascade-type reactor and motor-driven agitators for mixing the hydrocarbons with the acid. Construction will start this fall.

Only part of the current expansion program at this refinery, the unit will produce 1400 barrels daily of 100/130-octane aviation gasoline from a mixture of vapors comprising butylene, propylene and iso-butane.

Catalytic Construction Company has already begun work on a 11,000-barrel Houdry-engineered catalytic cracker which is scheduled for completion in July, 1952.

Other units included in the expansion are a vapor recovery unit, a reduced crude vacuum flasher, and a synthetic distillation and treatment unit. In addition, the existing 6000-barrel-a-day thermal cracker will be converted to a reforming unit.

Trinidad Topping Plant In 4000 Barrel Operation

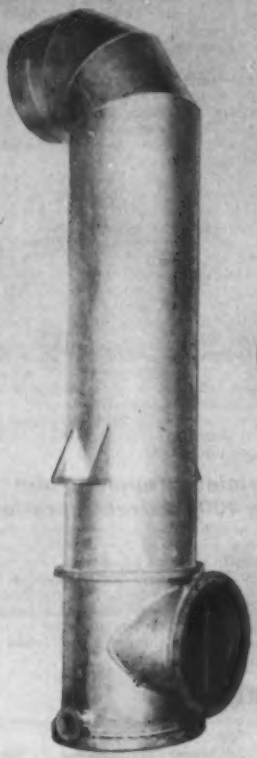
A 4000-barrel-a-day topping plant has been completed for the Brighton Terminal, Ltd., in La Brea, Trinidad. The 3000-barrel main fractionator, the flash tower and the new 5000-barrel furnace were erected by Chicago Bridge & Iron Company. The fractionator is one acquired from the old Kern Trinidad Oilfield, and modified.

REFINERY AND OTHER PLANT CONSTRUCTION

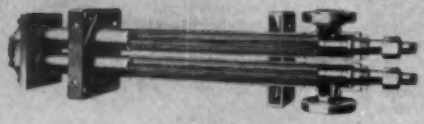
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
EAST									
*Allied Chemical & Dye	Hopewell, Va.	Synthetic Nitrogen	†60,000 tons yr.	$12.5 million	.....	.....	.....	.....	.....
Ashland Oil & Refining	Buffalo, N.Y.	Crude Unit Exp.	15,000 bbls.	.....	Under Constr.	1951	.....	.....	Cat. Constr.
Atlantic Refining Co.	Philadelphia, Pa.	Deterrent Mfg. Facilities	.....	$1.5 million	Under Constr.	1951	.....	.....	.....
Atlantic Refining Co.	Philadelphia, Pa.	Catalytic Reforming Unit	11,000 bbls.	$4 million	Under Constr.	Mid 1952	Atlantic	Badger	Badger
*Atlantic Refining	Philadelphia, Pa.	Two stage pipe still, Cat; Alky; Poly Units	80,000 bbl.	$5.6 million	.....	.....	.....	.....	.....
*California Refining	Perth Amboy, N. J.	Alkylation units	2,240 bbls.	$3.6 million	.....	.....	.....	.....	.....
*California Refining	Perth Amboy	Gas-Fuel Oil Additions	.....	$33 million	.....	.....	.....	.....	.....
Cambridge Gas Light Co.	Cambridge, Mass.	Light Oil Recov.	36 Mmcf	.....	Contracted	1951	.....	Blaw-Knox	Blaw-Knox
*Dewey & Almy Chemical Co.	Cambridge, Mass.	Synthetic Rubber Addition	.....	$404,000	.....	.....	.....	.....	.....
*Esso Standard Oil Co.	Baltimore, Md.	Vac.-Asphalt Still	.....	$284,000	Completed	.....	.....	Day & Zimmerman	Day & Zimmerman
*Esso	Bayway, N. J.	Boiler Plt. Ext.	.....	$830,000	Completed	.....	.....	Day & Zimmerman	Day & Zimmerman
Esso Standard Oil Co.	Bayway, N.J.	2 Demik. Units	50,000 each	.....	Under Constr.	1951	Howe-Baker	Fluor	Fluor
*Esso	Everett, Mass.	Fluid Cat. Crk.	†18,500 bbl.	.....	.....	Early 1953	.....	SOD	.....
*Esso	Everett	Rerun pipe still	†7,000 bbl.	.....	Under Constr.	1952	.....	SOD	.....
*Gulf Oil	Harmarville, Pa.	Research Lab.	.....	$1.1 million	Under Constr.	June, 1952	.....	.....	.....
*Gulf	Philadelphia, Pa.	Expansion	183,000 bbl.	$40.8 million	.....	.....	.....	.....	.....
*Gulf	Philadelphia	Crude Topping Unit	†76,000 bbl.	.....	.....	.....	.....	.....	.....
*Gulf	Philadelphia	Cat. Cracker	†8,930 bbl.	.....	.....	.....	.....	.....	.....
*Gulf	Pittsburg, Pa.	Ethylene Plt.	.....	$15.4 million	.....	.....	.....	.....	.....

* Table continued on page 80

Why G-FIN *is*



G-FIN Condenser for vapors of viscous liquids



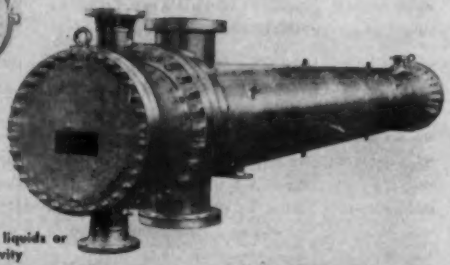
Twin G-FIN Section for heating or cooling fluids of low heat conductivity

G-FIN Storage Tank Oil Heater

G-FIN Gas Cooler

G-FIN Contactor Bundle for removing heat of a reaction

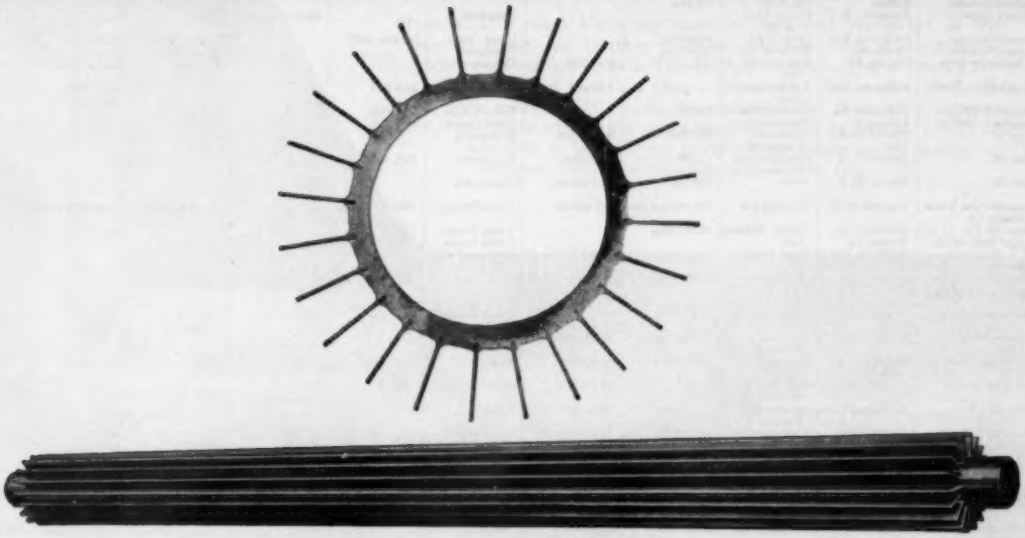
G-FIN fur-heated Fluid Heater



G-FIN Heat Exchanger for viscous liquids or gases of low heat conductivity

GRISCOM-RUSSELL: PIONEERS IN HEAT TRANSFER APPARATUS

superior for all these heat transfer duties



If your processes involve transfer of heat between fluids of unequal heat conductivity — these are the types of services for which G-R G-FIN apparatus is far superior to conventional units with bare tubes.

The longitudinal fins on the outside of G-FIN elements have six to eight times the heat transfer surface on the inside of the elements. Therefore, when a fluid of higher heat conductivity flows inside the elements, these fins provide the additional surface needed by a fluid of lower conductivity flowing outside the elements.

That's why G-FIN units require fewer tubes than bare tube units in such services. Fewer tubes mean fewer tube joints, easier cleaning, and less maintenance expense, as well as higher fluid velocities with least pressure drop.

Each G-FIN unit also has special design and construction features not possessed by conventional exchangers. Write for bulletin describing suitable G-FIN apparatus for services in which you are interested.

THE GRISCOM-RUSSELL CO., 285 MADISON AVENUE, NEW YORK 17, N. Y.

GRISCOM-RUSSELL

GR-231A

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Size	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Kendall Refining	Bradford, Pa.	Cat. Reformer	1,500 bbl.	$913,671					
Kendall Refg. Co.	Bradford, Pa.	Platforming Unit Reopened 4th	1,500 bbls.		Completed			U.O.P.	U.O.P.
Koppers Co., Inc. (Chem. Div.)	Kobuta, Pa.	Butadiene	20 million bbls.		Completed				
*Koppers	Kobuta	Styrene Monomer		$4 million	Design				
Louisville Refining Co.	Louisville, Ky.	Cat. Cracker	2,000 bbls.	$2 million	Under Constr.	1951		U.O.P.	
Mathieson Hydrocarbon Chemical Corp.	Brandenburg, Ky.	Chemical Plt.		$17 million	Under Constr.	End 1951		Badger, Stone & Webster	Badger, Stone & Webster
*Mathieson	Doe Run, Ky.	Isobutane Facilities	6,000 bbl.	$10 million	Announced				
*M. F. A. Oil	Memphis, Tenn.	Cat. Crk. & Aux.	2,200 bbl.	$1.7 million	Engineering				
*Monsanto Chemical	Addyston, Ohio	Styrene Plastics Plt.			Engineering				
*Monsanto	Charleston, W. Va.	Enlarg. Chem. Facilities		$9 million	Contracted	Spring, 1952			
New Bedford Gas & Edison Light Co.	New Bedford, Mass.	Light Oil Recov.	24 Mmcf		Under Constr.	1951		Blaw-Knox	Blaw-Knox
New York State Natural Gas Corp.	Boom Sta., Lawrenceville, Pa.	Nat'l.-Gas Dehydration Plt.	200,000 mcf	$380,000		1951		Blaw-Knox	Staff
Socony-Vacuum	Brooklyn, N.Y.	Houdry to TCC	15,000 bbls.		Completed		Socony-Vacuum	Foster Wheeler	Foster Wheeler
*Socony-Vacuum	Buffalo, N. Y.	Cat. Cracker	4,500 bbl.	$4.6 million	Engineering				
*Socony-Vacuum	Buffalo	Cat. Poly.	672 bbls.		Completed		Socony-Vacuum	Socony	Braun
*Socony-Vacuum	Paulsboro, N. J.	Enlarg. Bend Cat. Plt.			Under Constr.	3rd Qtr. 1952		Socony-Braun	Braun
*Socony-Vacuum	Paulsboro, N.J.	Crude Unit	46,000 bbl.		Completed			Socony-Braun	Braun
*Socony-Vacuum	Paulsboro	Reformer Unit	12,000 bbl.		Completed			Kellogg	Keen & Wise
L. Sonneborn Sons	Petrolia, Pa.	Antipollution Acid		$150,000					Day & Zimmerman
*Standard Oil Devel.	Baltimore, Md.	Still Replacement		$110,000	Under Constr.	End 1951			Kellogg
*Standard Oil-Calif.	Richmond, Va.	Vacuum Flasher	55,000 bbl.		Under Constr.	End 1951		Kellogg	Kellogg
*Standard Oil-Calif.	Richmond	Modernization			Under Constr.	End 1951		Kellogg	
*Sun Oil	Marcus Hook, Pa.	Benzene & Toluene Plt.	550/1000 bbl.	$8.4 million	Engineering				
*Sun Oil	Marcus Hook	Houdriforming Process	11,000 bbl.	$3 million	Engineering	Fall, 1952	Houdry		
*Sun Oil	Marcus Hook	Avgas	850 bbl.	$2.8 million	Engineering				
Tennessee Gas Transmission Co.	Greensburg, Ky.	Stripping Plt.	750,000 mcf gas	$12 million	Under Constr.	1951		Stone & Webster	Stone & Webster
Union Oil Co.	Edmonds, Va.	Asphalt Refinery	65,000 tons		Under Constr.	1951			Bechtel
United Refining Co.	Warren, Pa.	Lab.			Under Constr.	1951			
*U. S. Industrial Chemical	Baltimore, Md.	Ethyl Alcohol Plt.		$328,815	Announced				
MID-CONTINENT									
*Advance Refining	Centralia, Ill.	Perco Cat. Crk.	650 bbl.		Under Constr.	Oct., 1951	Phillips	Grebe & Doremus	Grebe & Doremus
*Allied Chemical & Dye Corp.	South Point, O.	Synthetic Nitrogen	50,000 tons yr.	$12.5 million	Design				
*American Cyanamid	Michigan City, Ind.	Synthetic Cat. Prod.	To 400 tons	$5 million	Engineering	June, 1952		Blaw-Knox	Blaw-Knox
*Ashland Oil & R.	Canton, Ohio	Gas, Jet. Fuel, Butane		$3.8 million	Under Constr.	Fall, 1951			
*Ashland Oil & R.	St. Elmo, Ill.	Gasoline & Kerosine		$665,000	Design				
Ashland Oil & Ref.	Canton, Ohio	Fluid Cat. Crk.	8,000 bbls.	$4 million	Under Constr.		U.O.P.	U.O.P.	McKee
Ashland	Canton	Gas Conc. Unit			Under Constr.		U.O.P.	U.O.P.	McKee
Ashland	Canton	Cat. Poly Unit	1,800 bbls.		Under Constr.			U.O.P.	McKee
Ashland	Canton	Add. Crude & Treating tankage	20,000 bbls.		Under Constr.			U.O.P.	McKee
Ashland	Findlay, Ohio	Crude Unit Expansion	12,000 bbls.		Completed			Staff	Cat. Constr.
*Ashland Oil & Refining	Wood River, Ill.	Topping; Crk.	5,000 1,200 bbl.	$665,000	Design				
*Aurora Gasoline & Keystone Oil	Detroit, Mich.	Refinery Expan.		$4 million	Announced				
Aurora Gasoline Co.	Detroit, Mich.	Platforming Unit	4,500 bbls.		Under Constr.	End, 1951	U.O.P.	U.O.P.	U.O.P.
*Bell Oil & Gas	Granfield, Okla.	Cat. Reformer	1,500 bbl.	$289,322	Design				
*Bureau of Mines	Otis, Kans.	Reopen Heli. Plt	48 Mcf/yr.	*$3 million	Under Constr.			*Original Cost.	
*Carbide & Carbon Chemical	Whiting, Ind.	Power Plt.		$3.7 million	Completed			Day & Zimmerman	Day & Zimmerman
*Carter Oil	Elmore City, Okla.	Gas Repres. Plt.	22,500 Mcfd.		Completed			Dresser	Dresser
Cities Service Oil Co.	Chicago, Ill.	Grease-Making Fac.	8.5 million lbs.		Planned	End 1951			
*Cities Sv. Oil-Del.	Ponca City, Okla.	Fluid Cat. Crk.	8,350 bbl.	$6.5 million	Under Constr.	Jan., 1952		Kellogg	Kellogg
*Cities Sv.-Del.	Ponca City	Crude Vacuum	21,000 bbl.		Under Constr.	Sept., 1951			Ford-Bacon-Davis
*Columbian Carbon	El Dorado, Ark.	Carbon Blk. Plt.	900 bbl.						
Columbian Carbon Co.	El Dorado, Ark.	Carbon Black Plt.	90,950 lbs.	$1.5 million	Under Constr.				
Continental Oil Co.	Ponca City, Okla.	Res. Lab. Bldg.		$2.3 million	Under Constr.	Fall 1951		Wigton-Abbott	Wigton Abbott
Derby Oil Co.	Wichita, Kans.	TCC Cat. Poly Gas Concent.		$2 million	Under Constr.	4th Qtr., 1952	Socony-U.O.P.	Fluor	Fluor
Dewese Oil Co.	Weston, Ohio	Lube Filtering	250 bbls.	$15,000	Under Constr.	1951		Staff	Staff
Dow Chemical	Midland, Mich.	2nd Hypersorption Unit			Contracted		Union Oil (Calif.)	Foster Wheeler	Foster Wheeler
*Dow Chemical	Ludington, Mich.	Bromine for TEL	2 million lbs. yr.	$433,500	Design				
*Dow Chemical	Midland, Mich.	Ethylene Dibromide		$370,000	Design				
*Dow Chemical	Midland	Vinyltoluene Plt.		$8 million	Constr. Fall	July, 1952		Stone & Webster	Stone & Webster
*Dow-Corning	Midland, Mich.	Methyl Chloride		$820,000	Design				
*Great Northern	St. Paul, Minn.	Crude Topping	30,000 bbls.						
*Great Northern Oil	St. Paul	Cat. Crk.	7,020 bbls.	$22.6 million	Under Constr.				
*Great Northern	St. Paul	Cat. Reformer	6,000 bbls.						
*Great Northern	St. Paul	Cat. Poly.	680 bbls.		Under Constr.	1951			
Hugoton Plains Gas & Oil Co.	Hooker, Okla.	Nat. Gasoline Stripping Plt.	2,380 bbls. Nat. Gas Prod.		Under Constr.	1951		U.O.P.	Staff
Indiana Farm Bureau Cooperative Assn.	Mt. Vernon, Ind.	Fluid Cat. Crk.	4,000 bbls.		Under Constr.	1951			U.O.P.
Indiana Farm Bureau	Mt. Vernon	Gas Concen.	3,500 bbls.		Under Constr.	1951			U.O.P.
Indiana Farm Bureau	Mt. Vernon	Vacuum Unit	300 bbls.						

■ Table continued on page 83

HUDSON AIR-COOLED UNITS

Hudson Air-Cooled Units are now transferring more than 500,000,000 BTU per hour of process heat from STEAM, GAS, JACKET WATER, HOT OIL and HYDROCARBON VAPORS directly to the air, obviating the use of water as an intermediate transfer medium.

Gears, drive shafts, fans, finned tube surfaces and structural steel supporting framework which make up the Hudson Air-Cooled Units are selected and designed for long life in continuous outdoor service. Drivers may be electric motors, steam turbines, gas engines, or hydraulic motors.

Hudson Air-Cooled Units are manufactured and assembled in the recently completed Hudson plant at Houston. This practice minimizes field assembly costs. The Hudson organization welcomes the opportunity of studying your over-all heat dissipation problem. Such studies will enable you to make the most advantageous selections of cooling equipment for your particular problem, whether it be cooling towers with water-cooled units, or air-cooled units, or combinations of the two.

HUDSON
ENGINEERING CORPORATION
FAIRVIEW STATION HOUSTON, TEXAS

BATTERY OF TWELVE HUDSON AIR-COOLED UNITS IN A TEXAS PROCESSING PLANT.
COOLING—HOT OIL AND GAS
CONDENSING—STEAM AND HYDROCARBON VAPORS

ORBIT VALVES®

Cut Valve Maintenance Costs with ORBIT

FORGED STEEL PRODUCTION VALVES L. P. GAS VALVES

ORBIT FORGED STEEL VALVES have set new standards of efficiency, simplicity and compactness in valve design. The Orbit Friction Free Seating Principle requires no lubrication of the sealing surfaces to effect a positive shutoff.

After installation ORBIT FORGED STEEL VALVES require infrequent attention because only nominal amounts of lubricant is required for the Stem mechanism.

ADJUSTABLE PLASTIC STEM PACKING is employed which is effective and permanent. This packing will seldom, if ever, need adjusting after the valve goes into service.

PRODUCTION VALVES

L. P. GAS VALVES

BRANCHES
HOUSTON, TEXAS
407 Velasco
(serving the Gulf Coast)
ODESSA, TEXAS
Starr Warehouse
(serving West Texas area)
CASPER, WYOMING
The Great Western Company
(serving the Rocky Mountains and Canada)

Your Supply Store Carries Orbit Valves in Stock

ORBIT VALVE COMPANY

P. O. BOX 699 TULSA, OKLAHOMA

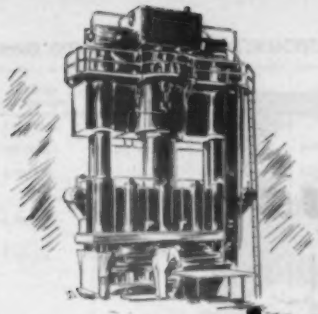
REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Size	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Johnson Oil Refg. Co.	Cleveland, Okla.	Platforming	1,800 bbls.	$750,000	Under Constr.	1951	.....	U.O.P.	Procon, Inc.
*Kanotex Refining	Arkansas City, Kans.	Fluid Cat	4,800 bbl.	$2.4 million	Under Constr.	June, 1952	U.O.P.	U.O.P.-Ref.Eng.	Ref. Eng.
*Kanotex	Arkansas City	Vacuum Unit	5,700 bbl.	.....	Completed	.....	U.O.P.	Ref. Eng.	Ref. Eng.
*Lake Superior Refg.	Superior, Wis.	New Refinery	4,000 bbl.	.....	Contracted	Dec., 1951	Phillips	Koch	Staff
*Lakeside Refining	Kalamazoo, Mich.	Cat. Reformer	.....	.....	.....	.....	.....	.....	.....
*Lion Oil	El Dorado, Kans.	Av-Gas Expan.	432 bbl.	$810,000	Design	.....	.....	.....	.....
*Lion Oil	Magnolia, Ark.	Sulfur Recovery	10 tons	.....	Under Constr.	Sept., 1951	.....	Graff	Graff
*Magnolia Petroleum	County Line, Okla.	Gas Plt Adds.	1,350 h.p.	.....	Completed	.....	.....	Dresser	Dresser
*Mercury Oil Refining	Oklahoma City	Cat. Crk.; Poly.	2,500/360 bbl.	$3.2 million	Design	.....	.....	.....	.....
*Mercury	Oklahoma City	Topping; Thermal	5,900/1,800 bbl.	.....	.....	.....	.....	.....	.....
*Midwest Refineries	Alma, Mich.	Cat. Reform.; Topping	1,500/6,300 bbl.	$933,700	Design	.....	.....	.....	.....
Midland Co-Op. Wholesale Co.	McPherson, Kans.	Expansion	22,000 bbls.	$4 million	Planned	.....	.....	.....	.....
Mid-West Refineries, Inc.	Alma, Mich.	Platforming Unit	1,500 bbls.	$932,700	Completed	.....	U.O.P.	U.O.P.	U.O.P.
Mississippi River Fuel Co.	Fredericktown, Mo.	Comp. Sta.	4,000 hp.	.....	Under Constr.	1951	.....	Ref. Maint.	Ref. Maint.
National Co-Op. Refinery Assn.	McPherson, Kans.	Polymerization, Fld Cat. Crk., Add tnkge, Util.	22,000 bbls.	$3 million	Under Constr.	.....	U.O.P.	Ref. Eng.	Ref. Eng.
*Northern Nat. Gas	Holcomb, Kans.	Gas Dehydration Plt. Addl.	.....	.....	Contracted	Jan., 1952	.....	Dresser	Dresser
*Northern Nat. Gas	Holcomb	Gas Refg. Plt.	185,000 Mcfd	.....	Contracted	Jan., 1952	.....	Dresser	Dresser
*Northern	Sublette, Kans.	Gas Dehyd. Addition	.....	.....	Considering	Nov., 1951	.....	Dresser	Dresser
*Northwestern Refining	St. Paul Park, Minn.	Topping & Cracking Unit	30,000 bbl.	$2 million	Preparing	Aug., 1953	.....	.....	.....
*Ohio Standard	Cleveland, O.	Crude Topping	7,000 bbl.	$4.2 million	Design	.....	.....	.....	.....
*Ohio Standard	Cleveland	Cracker; Poly	18,000/40 bbl.	.....	.....	.....	.....	.....	.....
Oklahoma Refg. Co.	Seminole, Okla.	Refinery	200 bbls.	$40,000	.....	.....	.....	.....	.....
*Old Dutch Refining	Muskegon, Mich.	Aromatic Fac.	150 B 370 T.	$515,120	Under Constr.	.....	.....	.....	.....
*Pan Am Southern	El Dorado, Ark.	Cat. Cracker	9,300 bbl.	.....	Completed	.....	.....	Foster Wheeler	Foster Wheeler
*Peppers Refining	Oklahoma City	Revamp Units	.....	.....	Under Constr.	.....	Phillips-U.O.P.	.....	Staff
*Peten Corp	Blue Island, Ill.	Cat. Cracker	7,500 bbl.	$1.9 million	Completed	.....	Peten	Houdry	J. C. Hinds
Petroleum Specialties	Flat Rock, Mich.	Cat. Cracker	3,000 bbls.	$2 million	Planning	.....	.....	.....	.....
Phillips Petroleum Co.	Okmulgee, Okla.	Cat. Crk. with Feed Prep. Unit & Gas Plt.	.....	.....	Planning	May, 1953	.....	.....	.....
*Petroleum Spec.	Flat Rock, Mich.	Cat. Reformer	900 bbl.	$700,000	Under Constr.	.....	.....	.....	.....
*Phillips Petroleum	Okmulgee, Okla	Car. Crk; Others	1800 bbl.	.....	Under Constr.	May, 1953	.....	Fluor	Fluor
*Pure Oil	Smith's Bluffs, Ark.	Alkylate Fac.	.....	$280,000	Announced	.....	.....	.....	.....
*Pure Oil	Toledo, Ohio	Cat Cracker	.....	$7 million	Plan	.....	.....	.....	.....
*Roosevelt Oil & Refining	Mt. Pleasant, Mich.	Benzene Plt.	.....	$1.5 million	.....	.....	.....	.....	.....
Shallow Water Refining Co.	Shallow Water, Kans.	Poly Unit	60 bbls.	$100,000	Completed	.....	U.O.P.	Koch	Staff
Shell Oil Co.	Elk City, Okla.	Gas Extrct Plt.	100,000 mcf gas	.....	Under Constr.	1951	.....	Ref. Maint.	Ref. Maint.
Shell Oil Co.	Mogadore, Ohio	Marketing Terminal	.....	$160,000	Under Constr.	1951	.....	.....	Poling & Bacon
*Shell Oil	Elk City, Okla.	Cycling Plt.	.....	.....	Completed	.....	.....	.....	.....
*Shell Oil	Wood River, Ill.	Aromatics	255 bbl.	$150,000	Design	.....	.....	.....	.....
*Shell Oil	Wood River	Petrochemical Plant	.....	.....	Completed	.....	.....	.....	.....
Shell Oil Co.	Wood River, Ill.	Platforming Unit	15,000 bbls.	.....	Under Constr.	Oct., 1951	U.O.P.	U.O.P.	Procon
*Sinclair Refining	E. Chicago, Ind.	Refinery Expan.	20,000 bbl.	.....	Under Constr.	Jan., 1952	.....	McKee	McKee
Socony-Vacuum	E. Chicago, Ind.	Houdry to TCC	15,000 bbls.	.....	Under Constr.	Aug., 1951	Socony-Vacuum	Socony-Braun	Braun
Socony-Vacuum	E. Chicago, Ind.	Houdry to TCC	.....	.....	Completed	.....	Socony-Vacuum	.....	Braun
*Socony-Vacuum	E. St. Louis, Ill.	Alky. Unit Rehab.	775 bbl.	$260,000	Design	.....	.....	.....	.....
Socony-Vacuum	Augusta, Kans.	Houdry TCC	15,000 bbls.	.....	Completed	.....	Socony-Vacuum	Fluor	Fluor
*Standard-Ind.	Neodosha, Kans.	Cat. Crk.; Alky. Unit	9,300 bbl.	$10 million	Under Constr.	End 1952	.....	.....	.....
*Standard-Ind.	Sugar Creek, Mo.	Crude Expan.	120,000 bbl.	$31 million	Preparing	End 1952	.....	.....	.....
*Standard-Ind.	Sugar Creek	Olefin Concentrate	.....	$142,000	Announced	.....	.....	.....	.....
*Standard-Ind.	Whiting, Ind.	Av-Gas Components	.....	$2.3 million	Under Constr.	End 1951	.....	.....	.....
*Standard-Ind.	Wood River, Ill.	Alcohols Prod.	.....	$2.6 million	Design	.....	.....	.....	.....
Standard Oil of N.D.	Grand Forks, N. Dakota.	Refinery	2,000-2,500 bbls.	.....	Planning	.....	.....	.....	.....
Standard (Ohio)	Lima, Ohio	Terminal Fac.	.....	$2 million	Planning	1951	.....	.....	.....
Standard (Ohio)	Toledo, Ohio	Terminal Fac.	.....	.....	Planning	1951	.....	.....	.....
Standard (Ohio)	Columbus, Ohio	Terminal Fac.	.....	.....	Planning	1951	.....	.....	.....
Standard (Ohio)	Cleveland, Ohio	Crd. Dist. Plt.	45,000 bbls.	$6½ million	Under Constr.	Jan., 1952	.....	McKee	McKee
Stanolind Oil & Gas Co.	Tulsa, Okla.	Research Center	.....	.....	Planning	.....	.....	Shreve, Lamb and Harmon Assoc.	.....
Stanolind Oil & Gas	Ulysses, Kans.	Gaso Plt. Exp.	200,000 mcf	.....	Planning	1951	.....	.....	.....
*Superior Refinery Owners, Inc.	Superior, Wis.	Topping	6,000 bbl.	$1.2 million	Under Constr.	.....	.....	.....	.....
		Thermal Crk.; Poly.	1000/34 bbl.						
*Sunray Oil	Duncan, Okla.	Alkylation Fac.	2,100 bbl.	$1.7 million	Design	.....	.....	.....	.....
*Texas Co.	Sparks, Okla.	Gas Comp. Sta.	625 hp.	.....	Completed	.....	.....	Dresser	Dresser
Texas Co.	Lawrenceville, Ill.	Expand Refinery	20,000 bbls.	.....	Under Constr.	1951	.....	Foster Wheeler Kellogg	Foster Wheeler, Kellogg
*Tide Water Assoc. Oil	Drumright, Okla.	Crude Topping; Vacuum	15,000 bbl. 6,000 bbl.	.....	Design	.....	.....	Ref. Eng.	Ref. Eng.
*Warren Petroleum	Antioch, Okla.	Plt. Additions	.....	.....	Completed	.....	.....	Staff	Dresser
*Warren	Maysville, Okla.	Plt. Additions	.....	.....	Under Constr.	Oct., 1951	.....	Staff	Dresser
*Western Oil & Fuel	Superior, Wis.	Topping, Cat. Cracker	10,000/3,000	$6 million	Under Constr.	.....	.....	.....	.....
*Wilcox Oil	Bristow, Okla.	Cat. Reformer	1,500 bbl.	$1 million	Design	.....	.....	.....	.....
*Wood River Oil Refining	Gary, Ind.	Crude Topping, Crak.; Poly.	15,000 bbl. 6,800/600 bbl.	$1 million	Design	.....	.....	.....	.....
SOUTHWEST									
*Acadia Corp.	Shreveport, La.	Motor gas unit	.....	$2.9 million	Design	.....	.....	.....	.....
*American Petro-Chemical Corp.	Lake Charles, La.	Chem. Plt.	.....	.....	Planned	.....	.....	.....	.....
Arizona Interstate	Florence, Ariz.	Refinery	15,000 bbls.	$25 million	Planning	1952	.....	Ebasco	.....
Arkansas-Louisiana Gas Co.	Blanchard, La.	4,200 hp Compressor Sta.	65,400 mcf	.....	Under Constr.	1951	.....	Staff	Delta

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
*Aromatics Refining	Baton Rouge, La.	Aromatics Fac.	.....	$11.6 million	Design	.....	.....	.....	.....
Atlantic Refining Co.	Port Arthur, Texas	Detergent Mfg. Facilities	.....	$1.5 million	Under Constr.	.....	.....	.....	.....
*Atlas Processing	Shreveport, La.	Extractive Distill.	17,000 gals.	$2.6 million	Under Constr.	Mar., 1952	U.O.P.	U.O.P.	Hudson
*Atlas	Shreveport	Platforming Unit			Under Constr.	Mar., 1952	U.O.P.	S.O.D.	Procon
*Atlas	Shreveport	Cat. Reformer	2,500 bbl.	$700,000	Under Constr.	Mar., 1952	.....	.....	.....
Barnsdall Oil Co., Op.	Sperry Co., Tex.	Nat. Gaso. Plt.	30,000 mcf gas	$6.5 million	Considering	1951	.....	.....	.....
Bay Petroleum Corp.	Chalmette, La.	Modernization of Cracking Fac.	6,000 bbls.	.....	Under Constr.	End 1951	U.O.P.	U.O.P.	Procon, Inc.
*Bay Petroleum	Chalmette, La.	Cat. Cracker	16,000 bbl.	$1.7 million	Under Constr.	Nov., 1951	U.O.P.	U.O.P.	Procon
*Bell Oil & Fas	Grandfield, Okla.	Cat. Reformer	1,500 bbl.	$290,322	Announced	.....	.....	.....	.....
*Bell Oil Corp.	Lake Charles, La.	Nat. Gas Plt.	12,000 Mcf	.....	Under Constr.	Oct., 1951	.....	Grebe & Doremus	Grove & Doremus
Cabot Carbon Co. (Godfrey L. Cabot, Inc.)	Big Spring, Texas	Carbon Black Plt.	136,500 lbs	.....	Completed	.....	.....	Cabot Eng.	Staff
*Cabot Carbon	Big Spring, Tex.	Two Carbon Black Plts.	.....	.....	Completed	.....	.....	.....	Staff
Cabot Carbon Co.	Bayou Sale, St. Mary Parish, La.	Thermal Black Plt.	136,500 lbs.	$4 million	Designing	1953	.....	.....	.....
Cabot Carbon Co.	Bayou Sale, St. Mary Parish, La.	Oil Furn. Carbon Blk. Plt.	82,192 lbs.	.....	Designing	1953	.....	.....	.....
*Carbide & Carbon Chemicals	Texas City, Tex.	Acetylene Plt.	.....	.....	Plan	July, 1952	.....	.....	.....
*Celanese Corp.	Pampa, Tex.	Chem. Plt.	.....	$3.5 million	Under Constr.	June, 1952	.....	Brown & Root	Brown & Root
*Col-Tex Refining	Colorado City, Texas	Cat. Poly. Plt.	.....	.....	Completed	.....	Cal Research	Grebe & Doremus	Grebe & Doremus
Commercial Petroleum & Transport Co.	Cold Spring Field, San Jacinto, Texas	Compressor, Dehydration, Metering	15 M mcf	$235,000	Under Constr.	1951	.....	Chas. F Sanderson	Pioneer
*Consolidated Chemical, Ind.	Baton Rouge,	Sulfur Plt.	50 tons	.....	Announced	.....	.....	Parsons	Parsons
Continental Oil Black Co.	Lake Charles, La.	Carbon Black Plt.	25 million lbs.	$15 million	Completed	.....	.....	.....	.....
*Continental Oil	Westlake, La.	Furnace Black	67,000 lbs.	$2 million	Under Constr.	Fall 1951	.....	.....	.....
*Continental Oil	Lake Charles, La.	Refinery Expan.	40,000 bbl.	$34 million	Under Constr.	Late 1952	.....	Badger-Conoco	Badger
Continental Oil Corp.	Lake Charles, La.	Expansion, Cat. Crk., add equip. for High Octane Production	40,000 bbls.	$34 million	Under Constr.	Late 1952	.....	Badger	Badger
Coseden Petroleum Corp.	Big Spring, Texas	Platforming Unit, and Recovery Facilities	3,800 bbls.	$3 million	Constr. Aug.	Summer 1952	.....	U.O.P.	Procon.
Cosden	Big Spring	Crude Still	4,000 bbls.	.....	Under Constr.	1951	.....	.....	.....
*Crown Central Petroleum	Houston, Texas	Crude Topping	2,350 bbl.	$365,000	Design	.....	.....	.....	.....
*Crown Central	Houston	Cat. Cracker	2,400 bbl.						
Del Ray Petroleum Co.	Chesterville, Texas	Pressure Absorption Plt.	35,000 mcf	.....	Under Constr.	.....	.....	O. L. Olsen	O. L. Olsen
Dodds Refining Co.	Jacksonville, Texas	Refinery Repairs	.....	.....	.....	.....	.....	.....	.....
Dow Chemical Co.	Freeport, Texas	Chemicals, Expansion	.....	$30 million	Engineering	End 1951	.....	Staff	Tellepsen, Pritchard, Austin, Stone & Webster
*Dow Chemical	Freeport, Texas	Styrene Plastics	.....	$1.6 million	Design	.....	.....	.....	.....
*Dow Chemical	Freeport	Ethylene-Dibromide Unit	.....	$8 million	Plan	.....	.....	.....	.....
*Dow Chemical	Freeport	Perchlorsethylene Chloride	.....	$3 million	Plan	.....	.....	.....	.....
E. I. Du Pont de Nemours & Co., Inc.	Orange, Texas	Expand Polythene Manuf. Facilities	60 Mmcf.	.....	Planning	Late 1952	.....	.....	.....
*Eddy Refining	Houston, Texas	Topping Unit	1,200 bbl.	.....	Under Constr.	Oct., 1951	.....	Grebe & Doremus	Grebe & Doremus
Esso Standard	Baton Rouge, La.	Dunking Unit	85,000 bbls.	.....	Under Constr.	1951	Howe-Baker	Staff	Pioneer
Ethyl Corp.	Houston, Texas	Chemicals Mfg. Plt.	100 mln. lbs./yr.	.....	Under Constr.	End 1951	.....	Braun, Badger	Braun-Badger
*Ethyl Corp.	Baton Rouge, La.	TEL Additions	83,000 lbs.	$4 million	Completed	.....	.....	C. F. Braun	Badger
*Ethyl-Dow	Freeport	Ethylene Dibromide	60,000 lbs.	$9.2 million	.....	.....	.....	.....	.....
Fullerton Oil Co.	Snyder, Texas	Refrig. Nat. Gaso. Plt.	40,000 mcf	.....	Under Constr.	1951	.....	.....	Hudson
*Gilmore Refineries	Odessa, Texas	New Refinery	30,000 bbls.	$40,000 million	Design	.....	.....	.....	Ford-Bacon-Davis
*Gulf Oil	Pt. Arthur, Tex.	Ethylene Plt.	45,000 lbs.	$15.4 million	Under Constr.	Spring, 1952	.....	.....	.....
*Gulf Oil	Pt. Arthur	Fluid Cat Crk.	60,000 bbl.	$18.4 million	Under Constr.	Sept., 1951	.....	.....	.....
Gulf Oil Corp.	Pt. Arthur, Tex.	Fluid Cat. Crk.	60,000 bbls.	$8 million	Under Constr.	Sept., 1951	.....	Kellogg	Kellogg
Gulf Oil Corp.	Pt. Arthur, Tex.	Iso-Octyl Alcohol Fac.	24,657 lbs.	.....	Planning	End, 1952	.....	.....	.....
*Gulf Oil	Waddell, Texas	Gas Plt. Add.	.....	.....	Plan	.....	.....	.....	.....
J. M. Huber Corp.	Baytown, Texas	Car. Blk. Plt.	107,000 lbs.	$1.5 million	Under Constr.	Nov., 1951	.....	Huber	Stearns-Rogers
Humble O&R	Baytown, Texas	3 stage Crude	48,000 bbls.	.....	Completed	.....	.....	Foster Wheeler	Foster Wheeler
Humble Oil	Baytown, Texas	Refrig. for Alky Unit	Summer 1900 bbls.	$177,845	Under Constr.	Fall, 1951	.....	Staff	Staff
Inland Refining	Palestine, Tex.	Cat. Poly	100 bbl.	.....	Under Constr.	1951	Cal Research	Grebe and Doremus	Grebe and Doremus
Inland	Palestine	Cyclo. Unit	400 bbls.	.....	Under Constr.	1951	Cal Research	Grebe and Doremus	Grebe apd Doremus
Inland	Palestine	Purco Cat.	700 bbls.	.....	Under Constr.	1951	Phillips	Grebe and Doremus	Grebe and Doremus
Jefferson Chemical Co.	Port Neches, Texas	Ethanolamine Plt.	.....	.....	Under Constr.	4th Qtr., 1951	.....	Braun	Braun
Koppers Co., Inc.	Pt. Arthur, Tex.	Chem. Plt.	.....	.....	Const. June	.....	.....	Koppers	Koppers
*Levelland Refining	Amarillo, Texas	Cat. Crk; Poly.	3000/150 bbls.	$2.4 million	Design	.....	.....	.....	.....
Lion Oil Co.	Diamond M & Sharon Ridge Fields, Texas	Casinghead and LPG Plt.	50,000 Mcf.	$6,500,000	Under Constr.	Aug. 1, 1951	.....	Hudson Eng.	Hudson and Others
*Lubrizol Corp.	Deer Park, Tex.	Chem. Plt.	.....	$2 million	Completed	.....	.....	Lubrizol	Brown & Root
Magnolia Petroleum	Beaumont, Tex.	Houdry to TCC	18,000 bbls.	.....	Completed	.....	.....	.....	Lummus
Magnolia	Hurricane Creek Field, Beauregard Parish, La.	Casinghead Gasoline Plt.	.....	.....	Designed	.....	.....	.....	.....

* Table continued on page 87



BS&B's Modern Tools and Facilities Are Ready to Help You

STEP-UP YOUR PRODUCTION!

● Expand your production "toolbox". Use the vast fabricating facilities of BS&B! Pressure vessels and large weldments built to most exacting specifications. Modern, high performance equipment in BS&B's spacious plants includes a huge 3,000-ton hydraulic press . . . automatic submerged-arc welding . . . one of the largest stress-relieving ovens west of the Mississippi . . . metallic arc, oxy-acetylene and inert-gas-shielded metal arc welding . . . new plate oven . . . bending brakes . . . flanging machines . . . plate bending rolls . . . *complete* machine shops . . . automatic sandblasting . . . X-ray inspection.

For over 58 years, BS&B has been a major supplier of precision, high pressure equipment to the petroleum and chemical industries. Workmen are skilled in the latest techniques. Code standards are maintained throughout. Inspections are frequent and thorough. A large, full-time staff of engineers is available for consultation and to help you prepare plans and specifications.

Write today for a complete description of BS&B's conveniently located, fully-experienced, completely equipped facilities. All inquiries held in strict confidence.

EFFICIENCY

BS&B

RELIABILITY

BLACK, SIVALLS & BRYSON, INC.

7502 East 12th Street Advertising Department Room 785 Kansas City 3, Missouri

...a sign you can believe in

You are apt to see this sign anywhere. It might be on a 'dozer "hogging out" a raw site for a refinery in Europe or the Near East; or on a 100-ton vessel in transit to South America, Canada, or the Orient; or on the control board of a petroleum chemical plant on the Gulf Coast. It might even be as close as the cover of a proposal lying on your own desk.

But wherever you see it, it symbolizes a project in capable hands—Lummus hands. It stands securely on its world-wide record—the designing and constructing of nearly 200 units of all types for the manufacture of motor gasoline, high octane aviation fuel, and fuel oils . . . more than 115 lube oil and wax processing plants . . . over 300 units for making chemicals and petroleum chemicals . . . and a score of complete refineries and chemical plants.

It's a good sign to look for, believe in, and rely on when you buy complete, integrated engineering service for *your* next project.

THE LUMMUS COMPANY

385 MADISON AVENUE, NEW YORK 17, N. Y.

CHICAGO • HOUSTON • LONDON • CARACAS • PARIS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
McMurrey Refining	Tyler, Texas	Fluid Cat.	5,000 bbls.	.....	Completed	.....	U.O.P.	U.O.P. and Ref. Eng.	Ref. Eng.
McMurrey Refining	Tyler, Texas	Poly Unit	350 bbls.	.....	Completed	1951	U.O.P.	U.O.P. and Ref. Eng.	Ref. Eng.
McMurrey	Tyler	Vac.-Flasher	4,000 bbls.	.....	Under Constr.	1951	.....	U.O.P. and Ref. Eng.	Ref. Eng.
McMurrey	Tyler	Revamp Thermal Crk.	.....	.....	Completed	1951	.....	U.O.P. and Ref. Eng.	Ref. Eng.
*Monarch Refining	San Antonio, Texas	Fluid Cat. Crk.	4,000 bbl.						
*Monarch	San Antonio	Poly. Unit	2,500 bbl.	$12.5 million	Design	Mid 1953	.....	U.O.P.	Koch
*Monarch	San Antonio	Alky. Unit	2,500 bbl.						
*Monsanto	Texas City	Styrene Plastics	.....	$8.6 million	Under Constr.	April, 1952	.....	.....	.....
Monsanto Chemical Co.	Texas City, Tex.	Acrylonitrile Mfg. Facil.; Plt. Expansion	.....	$30 million	Engineering	1953	.....	Braun	.....
North American Oil Consolidated & Ungren & Frazier	Bartlett Field, Jones County, Texas	Gaso. Plt., Gas Injection Facilities	.....	.....	Planning	.....	.....	.....	.....
*Northern Natural Gas	Skellytown, Tex.	Gas Dehyd. Plt.	180,000 Mcfd	.....	Contracted	Oct., 1951	.....	Dresser	Dresser
*Northern Natural Gas	Haidak, Texas	Comp. Plt. Add.	.....	.....	Completed	.....	.....	Staff	Dresser
*Northern Natural Gas	Bobbitt, Texas	Comp. Plt. Add.	.....	.....	Completed	.....	.....	Staff	Dresser
*Northern Natural Gas	McConnell, Tex.	Comp. Plt. Add.	.....	.....	Completed	.....	.....	Staff	Dresser
Onyx Refining Co.	Abilene, Texas	Platforming Unit, Thermal Crk. Still	550 bbls.	$650,000	Under Constr.	1951	U.O.P.	.....	Staff
*Pan Am Petroleum & Trans.	Texas City, Tex.	Av-Gas Expan.	11,180 bbls.	.....	Plan	End 1952	.....	.....	.....
*Pan American Refining	Texas City, Tex.	Aromatics-Toluene	900 bbl.	$1.1 million	Announced	.....	.....	.....	.....
*Pan American Refining	Texas City, Tex	Alky. Expan.	120,500 bbl.	.....	Plan	End 1952	.....	.....	.....
Pan Am Southern Corp.	Destrehan, La.	Cat. Crk. Unit Gas Plt., Alkylation	20,000 bbls.	$6.5 million	Planning	May, 1953	.....	Lummus	Lummus
*Pan-Am Southern	New Orleans, La.	Refinery Expan.	.....	$5.5 million	Announced	.....	.....	.....	.....
*Pan-Am Southern	Destrehan, La.	Fluid Hydro-former	2,000 bbl.	.....	.....	May, 1953	S.O.D.	S.O.D.	Kellogg
*Panhandle Prod. & Ref.	Wichita Falls, Texas	Topping Unit	6,000 bbl.	.....	Design	.....	.....	Ref. Eng.	.....
Phillips Chemical Co.	Borger, Texas	Carbon Black Plt.	80,000 tons/yr.	.....	Planning	4th Qtr., 1951	.....	.....	.....
*Phillips Oil	Borger, Texas	Alky. Expan.	.....	$15.5 million	Announced	.....	.....	.....	.....
*Phillips Pet.	Chocolate Bayou, Texas	Nat. Gas Plt.	3,570 bbl.	.....	Announced	.....	.....	.....	.....
*Phillips Pet.	Dumas, Texas	Comp. Stat. Add.	250,000 Mcfd	.....	Under Constr.	Sept., 1951	.....	Phillips	Phillips
*Phillips Pet.	Goldsmith, Tex.	Sulfur Plt.	120 tons	.....	Under Constr.	.....	.....	Parsons	Parsons
*Phillips Pet.	Goldsmith	Gas Inject. Comp.	30,000 Mcfd	.....	Completed	.....	.....	Phillips	Phillips
*Phillips Pet.	Midland, Texas	Nat. Gas Plt.	.....	.....	Announced	.....	.....	.....	.....
*Phillips Pet.	Phillips, Texas	Isobutane Separation	20,000 bbl.	$4 million	Under Constr.	Nov., 1951	.....	Badger	Badger
*Phillips Pet.	Sweeney, Texas	Crude Unit	30,000 bbl.	$4.8 million	Under Constr.	Aug., 1951	.....	Braun	Braun
*Phillips Pet.	Sweeney	Alkylate Unit	1,900 bbl.	$3.6 million	Under Constr.	Oct., 1951	.....	Braun	Braun
Phillips Petroleum	Alvin, Texas	Cycling Plt.	175,000 Mcfd	$5 million	Under Constr.	1951	.....	Brown & Root	Brown & Root
Phillips Petroleum	Phillips, Texas	Cat. Cracker	30,000 bbls.	.....	Completed	.....	.....	Braun	Braun
Pontiac Refining Co. & Chicago Corp.	Corpus Christi, Texas	Ref. Petro-chem. Plt.	5,000 bbls. gaso., 170,000 bbls ethylene glycol, 3,000 lbs. ethylene	$15 million	Design, Planning	1951	.....	.....	.....
*Premier Petroleum	Ft. Worth, Tex.	Cat. Reformer	1,500 bbl.	$850,000	.....	.....	.....	.....	.....
*Premier Pet.	Ft. Worth	Jet Fuel Butane, etc.	.....	$3.0 million	Design	.....	.....	.....	.....
Premier Petroleum	Ft. Worth, Tex.	Platforming Unit	1,500 bbls.	$750,000	Completed	.....	U.O.P.	U.O.P.	.....
Pure Oil Co.	Dollarhide, Andrews Co., Tex.	Nat. Gaso. Plt.	.....	16 million	Under Constr.	1951	.....	.....	Hudson
Pure Oil Co.	Nederland, Tex.	API Oil Sep.	.....	.....	Under Constr.	Fall, 1951	.....	.....	Trotti and Thompson
*Pure Oil	Smith's Bluff, Texas	Basic Refining	.....	$10.8 million	.....	.....	.....	.....	.....
*Pure Oil	Smith's Bluff	Alkylate Unit	1,901 bbl.	$390,000	.....	.....	.....	.....	.....
Shamrock Oil & Gas Corp.	McKee, Texas	Reconstruct Gaso. Ref. Treater	.....	$80,000	Planning	.....	.....	.....	.....
Shell Chemical Co.	Houston, Texas	Expand Ethylene & Ethyl Chloride Prod.; Glycerine Plt. Extension	.....	.....	Under Constr.	4th Qtr., 1951	.....	Fluor	Fluor
*Shell Oil	Houston, Texas	Benzene-Toluene	1,300/2,500 bbl.	$4.6 million	Design	.....	.....	.....	.....
*Shell Oil	La Porte, Texas	High Octane Expan.	.....	.....	Announced	.....	.....	U.O.P.	Procon
Shell Oil Co.	Houston, Texas	Platforming Unit	15,000 bbl.	$12 million	Under Constr.	Oct., 1951	U.O.P.	U.O.P.	Procon
*Sid N. Richardson	Odessa, Texas	Sulfur Recovery	20 tons	.....	Engineering	End 1951	.....	Graf	Graf
Sid Richardson Refining Co.	Texas City, Tex.	Refinery Alterations	30,000 bbls.	.....	Under Constr.	1951	.....	Staff	Staff
*Sinclair Refining	Houston, Texas	Crude Topping	25,000 bbl.	$27 million	Announced	.....	.....	.....	.....
*Sinclair	Houston	Cat. Cracker	40,000 bbl.						
*Sinclair	Houston	Desalting Unit	37,000 bbl.	.....	Under Constr.	End, 1951	Howe-Baker	Staff	Staff
*Southwestern Oil & Refining	Corpus Christi, Texas	Crude Topping	15,300 bbl.	$5.5 million	Design	.....	.....	.....	.....
*Southwestern	Corpus Christi	Cat. Crk.-Poly.	5,000/300 bbl.						
*Standard (Texas)	El Paso, Texas	Alkylation Unit	1,400 bbl.	$2.7 million	Start Fall, 1951	.....	.....	Kellogg	Kellogg
*Standard (Texas)	El Paso	Expansion & Modern Crk.	11,000 bbl.	$10.2 million	Under Constr.	July, 1952	Houdry	Cat. Constr.	Cat. Constr.
*Standard (Texas)	Houston, Texas	Natural Gasol	.....	$1.2 million	Announced	.....	.....	.....	.....
*Sun Oil	Delhi, La.	Topping-Benzene	130/197 bbl.	$238,497	Announced	.....	.....	.....	.....
*Sunray Oil	Tepetate, La.	Gas Plt. Add.	.....	.....	Completed	.....	.....	Dresser	Dresser
Sunray Oil Corp. (Op.)	Snyder, Texas	Gasoline Plt.	14,000 bbls.	$7.5 million	Completed	.....	.....	Fluor	Fluor
Superior Oil Co.	Ramsey Field, Colo. Co., Tex.	Nat. Gaso. Plt.	50,000-70,000 mcf. gas	$1.5 million	Under Constr.	1951	.....	Brown & Root	Brown & Root
Taylor Refining Co.	Corpus Christi, Texas	TCC Unit	12,000 bbls.	.....	Under Constr.	1951	Sweny-Vacuum	Lummus	Lummus
*Taylor Refining	Corpus Christi	Crude Unit	21,000 bbl.	.....	Under Constr.	.....	.....	Lummus	Staff
Taylor Refining Co. and Mayfair Minerals, Inc.	Port Isabel, Tex.	Platforming Unit	14,000 bbls.	.....	Under Constr.	Sept., 1951	U.O.P.	U.O.P.	Staff

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

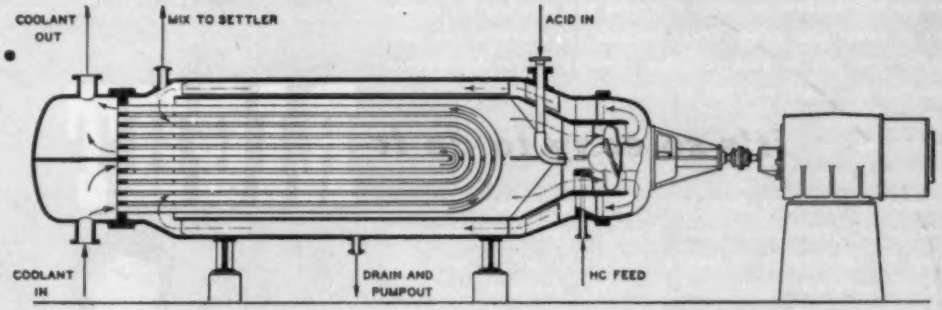
COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Texas City Refining, Inc.	Texas City, Texas	Reactivation Houdry Cat. Crk. and HF Alkylation	30,000 bbls.	$600,000	Completed	.....	U.O.P., Houdry	Staff	Staff
*Tennessee Eastman	Longview, Tex.	Ethyl Alcohol	.....	$5.7 million	Announced	.....	.....	.....	.....
*Tex.-Harvey Gas	Midland, Texas	Gas Plt.; Refrig.	35 Mcf wet	$3.5 million	Under Constr.	July, 1952	.....	.....	.....
United Carbon Co.	Shamrock, Texas	Carbon Black Plt.	66,500 lbs.	1.5 million	Under Constr.	1951	.....	.....	Staff
United Gas Pipe Line	Sterlington, La.	Dehydration	†25,000 mcf	.....	Under Constr.	.....	.....	.....	.....
United States Rubber Co.	Baton Rouge, La.	Buna W Rubber Plt. Expan.	82,200 lbs.	.....	Planning	Early, 1953	.....	.....	.....
ROCKY MOUNTAIN									
*Bureau of Mines	Rifle, Colo.	Demonst. Retort.	150-400 ton	$333,870	Engineering	June, 1952	.....	Blaw-Knox	Staff
*Continental Sulphur & Phosphate Corp.	Cody, Wyo.	Sulfur Extraction	.....	.....	Contracted	.....	.....	.....	Chem. Const.
*Filtrol Corp.	Salt Lake City, Utah	60 ton Cat. Crk.	447 bbls.	$728,606	Considering	.....	.....	.....	.....
*Filtrol	Salt Lake City	100 ton Cat. Crk.	745 bbls.	$1.9 million	Considering	.....	.....	.....	.....
*Frontier Natural Gasoline	Loco Hills, N.M.	Crude Topping Unit	*630 bbls.	$702,996	Completed	.....	.....	J. & L.	J. & L.
*Frontier	Loco Hills	Natural Gasoline	10,000 Mcfd	$2.5 million	Plan	.....	.....	.....	.....
*Garfield Chemical & Mfg. Corp.	Salt Lake City	Sulfuric Acid	.....	.....	.....	.....	.....	Hudson	Hudson
*Gulf Oil	Eunice, N.M.	3 Compressors	†15,000 Mcf	$600,000	Completed	.....	.....	.....	Sweco
New Mexico Asphalt and Refining Co.	Artesia, N.M.	Pkg. TCC Unit, Cat. Poly Unit	4,000 bbls. 300 bbls.	$2.5 million	Under Constr.	Aug., 1951	Scoggs-Vanuum Hydro Res.	.....	Sweco
Oriental Refining Co.	Denver, Colo.	Perco Cyclovercion Unit	1,500 bbls.	.....	Under Constr.	.....	.....	.....	.....
Phillips Petroleum Co.	Woods Cross near Salt Lake City, Utah	Vac. Plt., Gas Plt.; Storage, Cat. Crk.	8,000 bbls.	$10 million	Constr. Aug. 1951	July, 1952	.....	Fluor	Fluor
*Phillips	Borger, Texas	Fluid Cat. Crk.	30,000 bbl.	.....	Completed	.....	.....	Braun	Braun
*Southern Union Gas	Farmington, N. M.	H_2S Extension	.....	.....	Under Constr.	End, 1951	.....	Graff	Staff
*Western States Refg	Salt Lake City,	Topping; Crkrr.	3,000/2,200 bbls.	$1.1 million	.....	.....	.....	.....	.....
WEST COAST									
*American Smelting & Refining	Tacoma, Wash.	Sulfuric acid	.....	$891,730	Announced	.....	.....	.....	.....
*Dow Chemical	Pittsburgh, Cal.	Methylene Chloride	.....	$670,000	Announced	.....	.....	.....	.....
*Eureka Refining	Long Beach, Cal.	Cat. Crker	6,000 bbls.	$2.3 million	.....	.....	.....	.....	.....
*Fletcher Oil	Rancho San Petro, Cal.	Thermal Crker Addition	700 bbls.	$176,250	.....	.....	.....	.....	.....
*Fletcher Oil	Wilmington, Cal.	Gas & Fuel Oil	5,000 bbls.	$200,000	Completed	.....	.....	U.O.P.	Fletcher
Hancock Oil Co.	Long Beach, Cal	Ethylene Glycol	60,000 lbs.	.....	Considering	.....	.....	Badger	Badger
*Rothschild Oil	Santa Fe Springs, Cal.	Cat. Crker.	6,000 bbls.	$2 million	.....	.....	.....	.....	.....
Shell Chemical	Pittsburgh, Calif	Increase Ammonia Prod.	.....	.....	Completed	.....	.....	Staff	Staff
Shell Chemical	Shell Point, Calif.	Synthetic Ammonia Plt.	.....	.....	Planning	.....	.....	.....	.....
Shell Chemical	Shell Point	Refinery	25,000-50,000 bbls.	$25 million	Planning	.....	.....	.....	.....
Shell Chemical	Dominguez, Calif.	Added MIBK Prod. Capacity	.....	.....	Under Constr.	3rd Qtr., 1951	.....	Braun	Braun
Shell Chemical	Martinez, Calif.	Octyl, Formal Plt. Expansion	.....	.....	Under Constr.	1951	.....	Bechtel	Bechtel
*Signal Oil & Gas	Los Angeles, Cal	Butanes-Isobutane	.....	$500,000	.....	.....	.....	.....	.....
*Standard (Cal.)	El Segundo	Feed Preparation	.....	.....	Under Constr.	June, 1952	.....	Fluor	Fluor
*Standard (Cal.)	El Segundo	Platformer	10,000 bbls.	$7.4 million	.....	June, 1952	U.O.P.	U.O.P.	Procon
Standard Oil of Calif.	Richmond, Calif	TCC to Houdry	7,500 bbls.	$9 million	Under Constr.	Dec., 1951	Houdry	Houdry	Bechtel
Standard Oil of Calif.	Richmond	Residuum Strip	55,000 bbls.	.....	Completed	.....	.....	Kellogg	Kellogg
Standard Oil of Calif.	El Segundo, Calif.	Benzene Plt.	850 bbls. Benzene, 3,300 bbls. Toluene	$10 million	Under Constr.	Mid 1952	U.O.P.	Fluor	Fluor
*Stauffer Chemical	Richmond, Cal.	Sulfuric acid	.....	$283,500	.....	.....	.....	.....	.....
*Sunland Refining	Bakersfield, Cal.	Thermal Crker	900 bbls.	$501, 653	Under Constr.	Nov., 1951	.....	U.O.P.	Sunland
*Sunray Oil	Santa Maria, Cal.	Reconstruction	5,000 bbls.	.....	.....	.....	.....	Fluor	Process Constr.
Union Oil Co. of Cal.	Bren Olinda, Cal.	Research Plt.	.....	$5 million	Projected	1951	.....	Austin, Field and Fry	Walker
Union Oil Co.	Los Angeles, Calif.	Fluid Cat. Crk. Unit	28,000 bbls.	$8 million	Planning	Feb., 1952	U.O.P.	McKee	McKee
*Union Oil	Los Angeles, Cal	Crude Topping	20,000 bbls.	$12 million	.....	.....	.....	.....	.....
*Union Oil	Los Angeles	Alkylate Fac.	250 bbls.	$135,000	.....	.....	.....	.....	.....
*Union Oil	Oleum, Cal.	Asphalt Revin.	.....	$275,000	Under Constr.	Fall, 1951	.....	E. & A.	E. & A.
*Union Oil	Wilmington, Cal.	Cat. Cracker	28,500 bbls.	$4.5 million	.....	.....	.....	.....	.....
*Union Oil	Wilmington	Av.-Gas	.....	$135,000	.....	.....	.....	Bechtel	Bechtel
Union Oil Co. of Calif.	Edmonds, Wash.	Asphalt Refining	65,000 tons/yr.	$1 million	Under Constr.	1951	.....	.....	.....
U. S. Navy and Standard Oil of Calif.	Elk Hills, Calif.	Nat. Gas Plt.	50 Mmcf.	.....	Planned	April, 1953	.....	.....	.....
FOREIGN									
Canada									
British American Oil, Ltd.	Edmonton, Alberta	Refinery Offsite Facilities	.....	.....	Completed	.....	.....	Staff	Barnes
British-American	Edmonton, Alberta	Refinery	5,500 bbls.	.....	Completed	.....	.....	Can. Kellogg	Can. Kellogg
British-American	Moose Jaw, Sask.	Cat. Crk., Coker Thermal Crk., Cat. Poly., Utilities	10,000 bbls.	$5.5 million	Under Constr.	Dec., 1951	U.O.P. (Cat. Crk. & Cat. Poly.)	Pro. Eng.	Pro. Eng.
British American Oil and Shawinigan Chemicals	Montreal, East	Petro Chemical Plt.	.....	.....	Planning	.....	.....	.....	.....
Godfrey L. Cabot	Sarnia, Ont.	Carbon Black Plt.	.....	$1 million	Planning	.....	.....	.....	.....
Canadian Chemical Co.	Edmonton Area, Alberta	Petro Chemical Plt.	.....	$40 million	Planning	.....	.....	.....	.....
Canadian Oil Refineries	Promfield, Ont.	Refinery	20,000 bbls.	$18 million	Under Constr.	April, 1952	.....	Can. Kellogg	Can. Kellogg,
*Celanese Corp.	Edmonton, Alta.	Plat. Unit Chemical Plt.	3800 bbls.	.....	Under Constr.	1952	U.O.P	U.O.P.	Procon
Dominion Tar & Chemical Co., Ltd.	Montreal East	Petro Chemical Plt.	.....	$40 million $6 million	Announced Design	End 1952	.....	Badger	Badger

* Table continued on page 91

New STRATCO
Reg. U. S. Pat. Off.

ALKYLATION CONTACTOR

Provides High Octane and Re-run Yield With Either H_2SO_4 or HF Catalyst



FEATURING High Internal Isobutane Circulation. Large Heat Transfer Capacity at Low MTD. Cooling by Water or Refrigeration. Refrigeration Unaffected by Feed Analysis.

Low Construction and Maintenance Costs Assured . . . Simplified drive . . . motor or turbine. No supporting structure . . . simple foundation only. No acid recycle pump required. Piping simplified. No welds in cooling elements.

STRATFORD ENGINEERING
CORPORATION
Petroleum Refining Engineers

DIERKS BLDG. KANSAS CITY 6, MO.

RIGHT

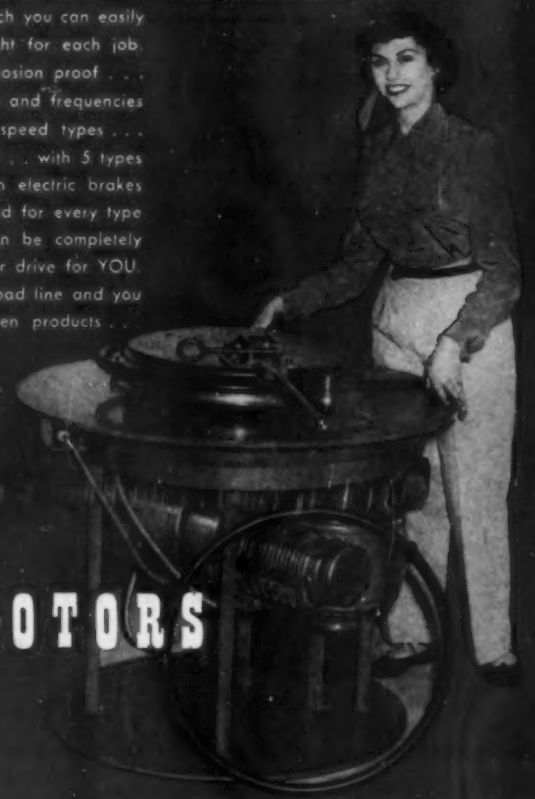
You can't beat the combination of the RIGHT horsepower, the RIGHT shaft speed, the RIGHT features all in one compact unit that you can use RIGHT where you want it. It's the best way and the easiest way to select your power drives because you purchase one unit, handle one unit in your receiving, production, or maintenance departments . . . set one unit in place and you're ready to go.

Master Motors, available in thousands and thousands of types and ratings (up to 150 HP) give you an enormous selection of integrally built power drives from which you can easily select the combination of features that's just right for each job.

Open, enclosed, splash proof, fan-cooled, explosion proof . . . horizontal or vertical . . . for all phases, voltages and frequencies . . . in single speed, multi-speed and variable speed types . . . with or without flanges or other special features . . . with 5 types of gear reduction up to 432 to 1 ratio . . . with electric brakes . . . with mechanical variable speed units . . . and for every type of mounting . . . Master has them all and so can be completely impartial in helping you select the one best motor drive for YOU.

Select the RIGHT power drive from Master's broad line and you can increase the saleability of your motor driven products . . . improve the economy and productivity of your plant equipment.

THE MASTER ELECTRIC COMPANY
DAYTON 1, OHIO



MASTER GEARMOTORS

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Ilmenite Refs., Ltd.	Lloydminster, Alberta	Ins. Capacity	3,000 bbls.	.....	Under Constr.	1951	.....	.....	.....
Ilmenite Refs., Ltd.	Lloydminster	Ins. Capacity	1,500 bbls.	.....	Design	1951	.....	.....	.....
Imperial Oil, Ltd.	Regina, Saskatchewan	Desalting Unit	16,000 bbls.	.....	Planned	1951	Howe-Baker	Staff	Staff
Imperial Oil	Winnipeg	New Refinery	10,000 bbls.	$10 million	Under Constr.	1951	.....	Canadian Kellogg	Canadian Kellogg
Imperial Oil	Edmonton, Alberta	Fluid Cat. Crk., Gas Recov. Plt. Vac. Dist. Unit	20,000 bbls.	$5 million	Under Constr.	Summer 1952	.....	Standard Oil Dev. Co.	Foster Wheeler
Imperial Oil	Sarnia	Fluid Cat. Crk., Dist., Light Ends Recov.	71,000 bbls.	$14 million	Under Constr.	Summer 1952	.....	Kellogg	Can. Kellogg
Imperial Oil	Sarnia	30 Storage Tanks	2 million bbls.	.....	Planning	.....	.....	.....	.....
Imperial Oil	Edmonton, Alta.	Desalting Unit	22,000 bbls.	.....	Planned	1951	Petreco	Staff	Staff
McColl Frontenac Oil Co., Ltd.	Edmonton, Alta.	Crd. Processing Cat. Crk.	8,500 bbls.	$10 million	Under Constr.	Sept., 1951	.....	Foster Wheeler	Foster Wheeler
*Midland Pet. & Pacific Pet.	Stettler, Alta.	Crude Refinery	4,000 bbls.	$2 million	Under Constr.	.....	.....	Process Constr.	Process Constr.
Panther Oil and Grease Co.	Leaside, Toronto, Ontario	Grease and Compounding	.....	.....	Projected	.....	.....	.....	.....
*Shell Oil	Jumping Pound, Alta.	Sulfur	33 tons	$500,000	Engineering	Early, 1952	.....	.....	.....
*Shell (Canada)	Montreal, East	Petro Chem Plt.	80,000 lbs.	$3 million	Under Constr.	Late 1952	.....	.....	.....
*Shell Oil	Shellburn, Ver.	Refinery Warehouse	.....	$300,000	.....	.....	.....	.....	.....
Supreme Refineries	Ogden, Alta.	Refinery	1,000 bbls.	$100,000	Under Constr.	1951	.....	Staff	Staff
Supreme Refineries	Ogden, Alta.	Asphalt Plt.	.....	.....	Planning	.....	.....	.....	.....
Latin America									
*Brighten Terminal	La Brea, Trinidad	Topping Plt.; etc.	4,000 bbls.	.....	Completed	.....	.....	.....	C. B. & I.
*Conselho Nacional do Petroleo	Bahia, Brazil	Expansion	5,000 bbls.	.....	Under Constr.	.....	.....	Kellogg	Kellogg
Conselho Nacional do Petroleo	Cubatao, Sao Paulo, Brazil	Therm. Crk. Ref. Reforming, Vis. Breaking Cat. Poly.	45,000 bbls.	.....	Under Constr.	End, 1953	.....	Hydrocarbon	Fiven-Lille & Schneider, Staff
Conselho Nacional do Petroleo	Mataripe, Bahia, Brazil	Ref. Expn Cat. Poly L.P.G., Plt.	2,500 bbls.	$3.5 million	Contracted	June, 1953	.....	.....	Kellogg
*Conselho Nacional	Salvador, Brazil	Combination Plt.	2,500 bbls.	.....	Under Constr.	.....	.....	Kellogg-P.A.	Staff
*Conselho Nacional	Salvador, Brazil	Cat. Poly. LPG	5,000 bbls.	.....	Under Constr.	.....	.....	Kellogg-P.A.	Staff
The Corporacion de Fomento de la Produccion	Concon, Valparaiso, Chile	Refinery	14,000 bbls.	$9 million	Planning	1953	.....	.....	.....
Creole Pet. Corp.	El Roble Field, Venezuela	Repressuring	.....	.....	Planning	.....	.....	.....	.....
Empresa Nacional del Petroleo	Cerro Manantiales, Tierra del Fuego	Crude Stabilizer, Nat. Gas., L.P. G. and Recycling	30,000 mcf gas	$2 6 million	Under Constr.	Nov., 1951	.....	Hudson Eng.	Staff under Hudson
Ipiranga S.A. Cia Brasilira de Petroleos	Rio Grande, Brazil	Therm. Crk. Ref.	2,000 bbls.	.....	Authorized	1952	Foster Wheeler	.....	.....
*Monsanto S.A.	Sao Paulo, Brazil	Plastics Plt.	.....	.....	Under Constr.	Late 1952	.....	.....	.....
*Petroleos Mexicanos	Atzcapotzalco	Desulfurization Plt.	12,000 bbls.	$995,000	Under Constr.	Nov., 1951	Perco	Phillips-McKee	McKee
*Petroleos Mexicanos	Mazatlan	Refinery	15,000 bbls.	.....	Projected	.....	.....	.....	.....
Petroleos Mexicanos	Ciudad Madero, Mexico	Desulfurization Units	12,000 bbls.	$1.5 million	Under Constr.	Dec., 1951	Perco	McKee-Phillips	McKee
Petroleos Mexicanos	Tamaulipas, Ciudad Madero, Mex.	Enlarge Refinery Capacity	47,330 bbls.	.....	Planning	1951	.....	.....	.....
Petroleos Mexicanos	Tamaulipas, Arbol Grande Pet., Mex.	Enlarge Refinery	16,500 bbls.	.....	Planning	1951	.....	.....	.....
Petroleos Mexicanos	Poza Rica, Mex.	Desulfurization Units	3,000 bbls.	$400,000	Planning	1951	Perco	Phillips	Staff
Petroleos Mexicanos	Mata Redonda, Vera Cruz, Mex.	Improvements	9,000 bbls.	.....	Planning	1951	.....	.....	.....
Petroleos Mexicanos	Poza Rica, Mex.	Improvements to Skimming Plant	3,100 bbls.	.....	Planning	1951	.....	.....	.....
Petroleos Mexicanos	Poza Rica, Mex.	Gas Purification, Pressure Maint.	100,000 bbls.	$13 million	Completed	.....	.....	McKee	McKee
Petroleos Mexicanos	Reynosa, Mex.	Expansion	.....	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Salina Cruz, Mexico	Refinery	.....	.....	Planning	.....	.....	.....	.....
Petroleos Mexicanos	Salamanca, Mex.	Lube Oil and Paraffin Plt.	2,500 bbls.	$18 million	Under Constr.	1952	Texaco	McKee	McKee
Phillips Oil Co.	San Roque Fld., Anzoategui, Venezuela	Refinery, Wax Plt.	2 mln. lbs. wax/ year	.....	Planning	1952	.....	.....	.....
Phillips	San Roque Fld., Anzoategui, Venezuela	Crude Stab. and Pressure Maint. Plt.	10,000 bbls. and 38 Mmcf.	.....	Planning	.....	.....	.....	.....
Phillips	San Roque	Crude Distill.	2,000 bbls.	.....	.....	.....	.....	.....	.....
*Private Group	Rio de Janeiro, Brazil	Refinery	20,000 bbls.	.....	.....	.....	.....	.....	Kellogg
Puerto Rican Oil Refining Co.	Near Ponce, Puerto Rico	Refinery	25,000 bbls.	$20 million	Projected	1951	Undetermined	Parsons, Brinckerhoff, Hall and Macdonald	.....
*Refinaria de Petroleo do Districto Federal S.A.	Manguinhos, Brazil	Refinery	10,000 bbls.	$10 million	Contracted	Aug., 1952	.....	.....	.....
*Refinaria de Petroleo Federal	Mataripe, Brazil	Refinery Expansion	12,500 bbls.	.....	Announced	.....	.....	.....	.....
Refinaria de Petroleos do Distrito Federal S.A.	Rio de Janeiro, D. F. Brazil	Therm. Crk.	10,000 bbls.	.....	Authorized	.....	.....	.....	Fiven, Lille, Schneider, Staff Foster Wheeler
Refinaria e Explorasao de Petroleo Uniao S.A.	Capuava, Sao Paulo, Brazil	Therm. Crk. Ref.	20,000 bbls.	.....	Authorized	.....	.....	P.A. Hydro. Ros.	Czech. Fact. Metal Work Mech. Constr.
Richmond Exploration Co.	Bajo Grande, Venezuela	New Refinery	35,000 bbls.	.....	Referred	.....	.....	.....	.....
Shell Co. of Venezuela	Cardon, Ven.	Comprehensive Refg.	38,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
Trinidad Leaseholds, Ltd.	Trinidad	Refinery addition	.....	$200,000	Designing	.....	.....	H.W.P.	H.W.P.

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Yacimientos Petroliferos Fiscales	Buenos Aires, Argentina	New Refinery	28,000 bbls.	$64 million	Design	1951	.....	Kellogg	Kellogg
YPF	La Plata, Argentina	Crude Topping, Gaso. Treating	30,000 bbls.	$3.5 million	Under Constr.	1951	.....	Houdry Process Cat. Constr.	Cat. Constr.
YPF Boliviano	Sucre, Bolivia	Additional Unit	3,000 bbls.	.....	Under Constr.	1951	.....	.....	Foster Wheeler
Europe and Africa									
Esso Petroleum	Fawley, Eng.	Refinery	110,000 bbls.	$180 million	Under Constr.	Jan., 1952	.....	Foster Wheeler	Foster Wheeler
Esso Petroleum	Fawley, Eng.	Poly Unit	.....	.....	Design	.....	.....	.....	.....
Esso Petroleum	Fawley, Eng.	SO_2 Extraction	12,000 bbls.	.....	Design	.....	.....	Badger	Badger
Esso Petroleum	Fawley, Eng.	Fluid Cat. Crk.	1 million gals.	.....	Under Constr.	Aug., 1951	.....	Esso Eng.	Foster Wheeler
*Anglo Iranian	Kent, England	Expansion	30,000 bbls.	.....	Engineering	1952	.....	.....	.....
Anglo-Iranian Oil	Isle of Grain, Eng.	New Refinery	40,000 bbls.	.....	Under Constr.	End, 1952	.....	Badger, Lummus, Kellogg	Badger, Lummus, Kellogg
Anglo-Transvaal Consolidated Investment Co.	Vall River, Union of South Africa	Synthetic Gasoline and Diesel Oil Plt.	.....	$30-40 million	Contracted	.....	.....	Hydro. Res.	.....
*Anonima Italiana Petroli	Ancona, Italy	Refinery	10,000 bbls.	.....	Completed	.....	.....	Local	Breda
Aquila, S.A.	Trieste, Italy	Prop. Deasph., Furf. Sol. Ref. MEK Dewax. Contact Filtr. Dist. & Blending Plt.	100 tons 96 U1 Lubes & Bright Stocks 8 tons all Paraffin Waxes	$7.9 million	Under Constr.	1951	Juik, Texaco	Badger	Badger
Aquila, S.A.	Trieste, Italy	Lube Oil Ref.	900 bbls.	$7.9 million	Under Constr.	Fall, 1951	Juik, Texaco	Badger	Badger
Azienda Generale Italiana Petroli	Cortemaggiore Field, Italy	Gasoline Extraction Plt.	105 Mmcf Ft.	$2.5 million	Under Constr.	End 1951	.....	J. F. Pritchard & Co.	North American Pet. Gas Corp.
Batavasche Pet. Mij.	Pernis, Holland	Expansion	73,500 bbls.	.....	Under Constr.	2nd Half, 1951	.....	.....	.....
*Benzene & Pet. Co. of Hamburg	Hamburg-Finkenwerder, Werder, Germ.	Expansion	660,000 bbls.	.....	Announced	.....	.....	.....	.....
William Briggs & Sons, Ltd.	Camperdown, Scotland	Crude Dist. Fac.	1,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
California-Texas Oil Co.	Pernis, Netherlands	Expanding Refinery	26,000 bbls.	.....	Under Constr.	Early 1952	.....	Various Local	Various Local
Cie de Raffinage Shell-Berre	Berre, France	Expansion	55,000 bbls.	$31.6 million	Under Constr.	Early, 1952	.....	.....	.....
Shell-Berre	Petit Couronne	Teepol Plt.	25,000 tons/yr.	.....	Under Constr.	1951	.....	.....	.....
Shell-Berre	Petit Couronne, France	Lube Unit	.....	.....	Planned	.....	.....	.....	.....
Cie Francaise de Raffinage	La Mede, France	Cat. Crk., Gas Recov. System	11,500 bbls.	$10 million	Authorized	1953	.....	.....	.....
Cie Francaise de Raffinage	Gonfreville, France	Gas Recov. System							
Cie. Francaise de Raffinage	Gonfreville, France	Therm. Reform., Prop. Deasp., Furf. Trtng.	4,750 bbls.	$11 million	Under Constr.	1952	Texaco & Juik	Kellogg	Local
Cie. Francaise de Raffinage	Gonfreville, France	Lube Unit	2,500 bbls.	.....	Under Constr.	1951	Texaco	Kellogg-Lummus	.....
Cia Espanola de Petroleos, S.A.	Sta. Cruz de Tenerife, Canary Islands	Propane-Butane Fractionating	204 bbls.	$100,000	Under Constr.	1951	.....	U.O.P.	U.O.P.
C.E.P.S.A.	Santa Cruz de Tenerife	Reforming Unit	6,000 bbls.	$1 million	Planned	.....	U.O.P.	U.O.P.	Foster Wheeler
C.E.P.S.A.	Canary Islands	Propane-Deas.	700 bbls.	$300,000	Under Constr.	1951	Standard Oil	Foster Wheeler	Foster Wheeler
C.E.P.S.A.	Santa Cruz de Tenerife (Canary Islands)	Percolation Unit	400 bbls.	.....	Under Constr.	1951	.....	.....	.....
Condor, S.P.A. Per l'Industriale Pet. Chemica	Rho, Italy	New Refinery	27,000 bbls.	.....	Under Constr.	1952	.....	Badger	Badger
		Cat. Cracker	†15,000 bbls.	.....	Under Constr.	1952	.....	Badger	Badger
"Condor"	Rho, Italy	Atm. Dist. Plt.	30,000 bbls.	.....	Under Constr.	1952	.....	Badger	Badger
"Condor"	Rho, Italy	Feed Prep.,	15,000 bbls.	.....	Under Constr.	1951	.....	Badger	Badger
		TCC Unit	10,000 bbls.	.....	Under Constr.	1951	Sec. Vac.	Badger	Badger
"Condor"	Rho, Italy	Recov. Purification Plt., Adm. Bldg., Pwr. House	.....	.....	Under Constr.	1952	.....	Badger	Badger
Danish Government	Denmark	Refinery	21,000 bbls.	.....	Planned	.....	.....	.....	.....
Deutsche-Amerikanische Petro-Gesellschaft (Esso)	Hamburg-Harburg, Germany	Cracking Plt.	8,843 bbls.	.....	.....	4th Qtr., 1953	.....	.....	.....
Deutsche Erdoel, A. G.	Heide, Germany	Cracking Fac.	†2,800 bbls. Gas ††1,250 bbls. Diese	.....	.....	Dec., 1951	.....	.....	.....
*Deutsche Vacuum Oel A.G.	Hamburg, Germany	Cracking Unit	8,000 bbls.	.....	Under Constr.	Sept., 1952	.....	Socony-Vac.	Hutte
Egyptian Government	Cairo, Egypt	Crude Plt.	.....	.....	.....	.....	.....	Lummus	Lummus
Egyptain Government	Suez, Egypt	Inc. Refn. Cap.	26,000 bbls.	$2,600,000	Planning	.....	.....	.....	Lummus
Esso Standard Refg.	Antwerp, Belg.	New Refinery Incl. Crker.	25,000 bbls.	.....	Authorized	July, 1953	.....	Standard Oil Dev. Co.	.....
Gewerkschaft Erdoel-Raffinerie Emsland	Near Lingen, Germany	Refinery	11,535 bbls.	$8,670,000	Under Constr.	4th Qtr., 1952	Houdry	Lummus	Lummus
		Houdry Cat.	7,000 bbls.						
Industrie Chimiche Italiane Petroli	Mantau, Italy	Crude Ref.	4,500 bbls.	.....	Contracted	Aug., 1952	.....	Koch	Staff
Industria Petrolifera e Chimica	Milam, Italy	Gasoline Fuel Oil Plt.	20,000 bbls.	.....	.....	.....	.....	Dr. Calogero Inglogio	.....
Industria Raffinazione Olii Minerali (IROM)	Porto Marghera, Italy	Crk. equipment	4,000 bbls.	$2 million	Planning	.....	.....	.....	.....
Imperial Chemical Industries, Ltd.	Wilton, Yorkshire, England	Petroleum Cracking Unit	2,000 bbls.	.....	Under Constr.	1951	.....	Kellogg	Kellogg
*I. P. S. A.	Rotkreus, Switz.	Cat. Reformer	.....	.....	Contracted	Jan., 1952	Phillips	Koch	Staff
L'Alliance Petrofina	Antwerp, Belg.	Refinery	21,000 bbls.	.....	Planned	.....	.....	.....	.....
Manchester Oil Refinery, Ltd.	Partington, England	New Lube Refinery	30,000 bbls.	.....	Projected	.....	.....	.....	.....
*Mineralol-und Asphaltwerke, A.G.	Ostermoor, Germany	Reconstruction	1,196 bbls.	.....	.....	.....	.....	.....	.....
Monsanto Chemical Co.	Britain	Add Polystyrene	.....	.....	Under Constr.	1951	.....	Staff	Staff
*Montecatini Co.	Ferrara, Italy	Olefin Plt.	450 bbls.	$18.6 million	Contracted	Mid 1953	.....	Kellogg	Kellogg
National Oil Refineries, Ltd.	Llandarcy, Wales	Vacuum Unit	17,000 bbls.	.....	Under Constr.	End, 1951	.....	Badger	Badger
N.O.R.	Llandarcy	Propane Deasphalting	3,500 bbls.	.....	Under Constr.	End, 1952	J.U.I.K.	Badger	Badger
N.O.R.	Llandarcy	Furf. Ext.	1,250 bbls.	.....	Under Constr.	End, 1952	Texaco	Badger	Badger
N.O.R.	Llandarcy	M.E.K. Dewaxing	1,700 bbls.	.....	Under Constr.	End, 1952	Texaco	Badger	Badger
N.O.R.	Llandarcy	SO_2 Kerosene Ext.	2,000 bbls.	.....	Under Constr.	1951	.....	H.W.P.	Staff

* Table continued on page 95

BRIDGEPORT BRASS COMPANY
CONDENSER AND HEAT EXCHANGER TUBE EDITION
COPPER ALLOY BULLETIN
"Bridgeport" MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL

Dezincification Can Be Retarded

It is clearly evident that certain deposits of either corrosion products or porous materials may set up corrosion cells which initiate dezincification in brass. Therefore, whatever steps can be taken to prevent such deposits from attaching themselves to the metal surface will help reduce dezincification. It should be recognized from the outset that these porous deposits do not need to be any larger in diameter than the point of a pin.

At least five methods have been used to retard dezincification; namely—

1. Mechanical cleaning.
2. Chemical cleaning.
3. High velocity or turbulent flow.
4. Formation of protective coatings.
5. Use of inhibited alloys—arsenical admiralty or arsenical aluminum brass.

Effect of Silt

Muntz metal, non-inhibited Admiralty and non-inhibited aluminum brass condenser tubing, kept clean by the scouring action of small amounts of sand and certain types of fine silt entrained in the circulating water, or by chlorination and frequent brushing, have corroded at low rates (generally .001 ipy or less).

Yellow brass and Muntz metal piping and tubing kept free from various deposits have given very long service.

Effect of Turbulence

The high degree of turbulence found at the entrance end of brass condenser tubes has been observed as being very effective in preventing dezincification for a distance of a few inches up to two feet. Under very turbulent conditions dezincification has virtually been completely prevented along the entire length of such tubes. Where the turbulent condition exists at the entrance end only, non-inhibited brass alloys may be subject to slow attack about .022 ipy along the remainder of the tube length. However, it must be remembered that high turbulence is often associated with impingement corrosion. Here impingement - resistant alloys such as aluminum brass, aluminum bronze and cupro nickel serve best.

It has also been observed that propellers cast from high strength brasses, which have been in constant service in sea water for many years, have shown virtually no dezincification although there may be some evidence of erosion and cavitation. On the other hand, propellers idle for some time may be subject to rapid dezincification.

Effect of Protective Scales

Certain waters which have deposited magnesium silicate or silica scales or coatings on brass surfaces are without effect on the brass. Under such conditions these silica or silicate scales are completely protective to the underlying metal and the alloy may last indefinitely. Dense adherent calcium carbonate scales are also effective in reducing or preventing dezincification but if too thick they will cut down the heat transfer rate.

Non-Scaling Waters Are Corrosive

Dezincification is most likely to occur in non-scale forming fresh or salt waters. In many instances, difficulty from dezincification in susceptible brasses is unknown until such time as a scale forming water is softened. Then it becomes necessary to use those copper-base alloys which are resistant to dezincification such as red brass, inhibited yellow brasses, arsenical Muntz, Admiralty or aluminum brass. The other alternative is to hold the mineral balance in the water at such a level that it will be slightly scale-forming.

It has been clearly demonstrated over a period of years that the greatest difficulty due to dezincification in non-inhibited yellow brasses has occurred in non-scale forming waters. For the most part such waters have a calcium carbonate saturation index of from minus 0.5 up to minus 3.5. This is usually characteristic of a water having a low total solids and calcium content and an appreciable amount of bicarbonate.

Effect of pH Values

Dezincification can occur in fresh and salt waters with the pH ranging from 5.0 to 8.0 or higher. The pH value in itself is not particularly significant. It can, however, become very important where adjustment in the pH may lead to mineral scale formation or the dissolving of mineral scales.

Non-scale forming waters, such as a solution of sodium chloride, will lead to dezincification in a non-inhibited yellow brass in the presence of deposits at any pH value, ranging from pH 1.0 up to a pH of 12. In such media, however, the tendency of plug-type dezincification is more marked in the higher pH range and the tendency for general dezincification is greater in the lower pH range, with a rather broad twilight zone in the central section of the pH scale. This is evidently due to the solubility of the zinc corrosion products in solutions having either a very low or a very high pH value.

At this point, it is of interest to note that sea water having a pH of 8.0 leads to general dezincification of uninhibited Muntz metal at a rate of about .009 ipy. (6830)

ALCOA
ACTIVATED* ALUMINA
dehydrates AIR and liquid PROPANE

for the Texas Natural Gasoline Corporation at Wimberly Plant, Tye, Texas

☆ The propane towers shown in the photo dry approximately 30,000 gallons of propane daily to a dew point of *minus* 40° F.

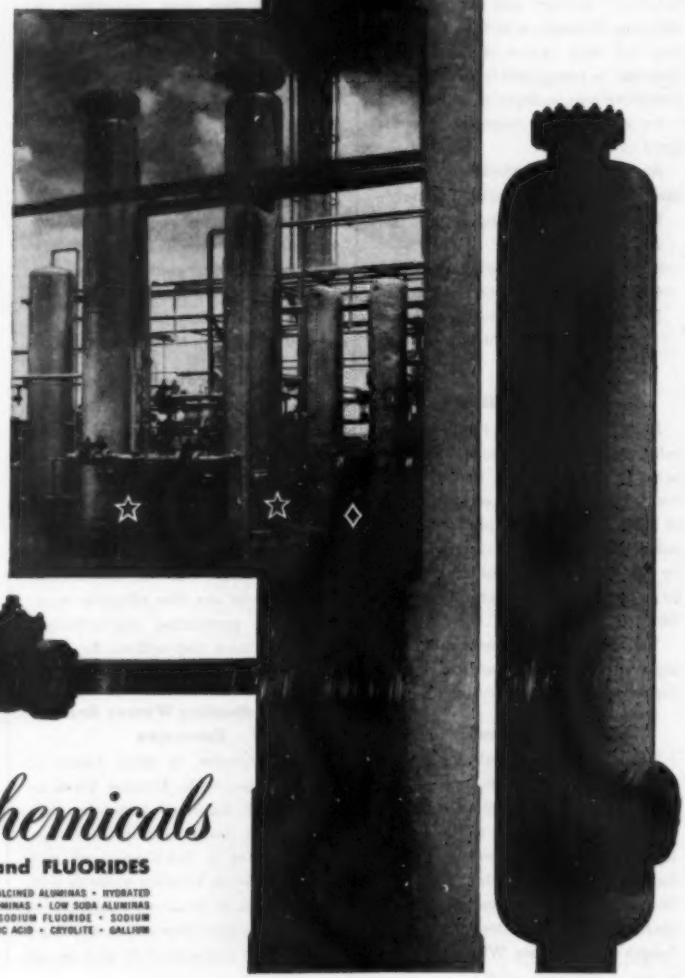
◊ The air drying towers dehydrate approximately 43,000 cu. ft. of air per day to a dew point of *minus* 20° F.

Operated since October, 1948, these two units show the day-in-day-out dependability of ALCOA *Activated* Alumina—a desiccant that can be reactivated an almost unlimited number of times without appreciable effect on its moisture adsorption efficiency. Alumina particles are strong . . . do not break down on repeated cycles of saturation and reactivation. Neither liquid water nor wet steam causes disintegration.

ALCOA *Activated* Alumina not only dries liquids and air but also dehydrates gaseous hydrocarbons to lower dew points than any other commercial adsorbent.

If you want to take advantage of the economies ALCOA *Activated* Alumina offers as a drying agent, write to: ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 617G Gulf Bldg., Pittsburgh 19, Pa.

*Reg. T. M., *Aluminum Co. of America*



Alcoa Chemicals

ALCOA

ALUMINAS and FLUORIDES

ACTIVATED ALUMINAS • CALCINED ALUMINAS • HYDRATED ALUMINAS • TABULAR ALUMINAS • LOW SODA ALUMINAS ALUMINUM FLUORIDE • SODIUM FLUORIDE • SODIUM ACID FLUORIDE • FLUOBORIC ACID • CRYOLITE • GALLIUM

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
National Oil Refineries, Ltd.	Llandarcy, Wales	Additional Boilers	.....	.....	Under Constr.	1952	.....	Ewbank & Partners	.....
N.O.R.	Llandarcy	Generating Plant	13,000 KW	.....	Authorized	1952	.....	Ewbank & Partners	.....
N.O.R.	Llandarcy	Cat. Crk.	10,000 bbls.	$48 million	Under Constr.	Early 1953	.....	Kellogg	Kellogg
A/S Norsk Amerikansk Mineraloljekompagni	Vallø, near Tonberg, Norway	Lube Oil, Asphalt	1,000 bbls.	.....					
Pechelbronn, S.A. E. M.	Merkwiller, France	Capacity Increase	1,500 bbls.	.....	Authorized	1951	.....	.....	.....
Pormolio, S.P.A., Raffinerie Italiane Olii Minerali	Genoa, Italy	Cat. Cracker	1,630 bbls.	.....	Planning	4th Qtr., 1951	.....	Foster Wheeler	Foster Wheeler
Pormolio, S.P.A.	Milan, Italy	Perco Reforming Unit	350 bbls.	.....	Planning	1951	.....	.....	.....
Pormolio, S.P.A.	Rome, Italy	Cat. Cracker	1,630 bbls.	.....	Planning	4th Qtr., 1951	.....	Foster Wheeler	Foster Wheeler
Petrochemicals, Ltd.	Partington, England	Petrochemicals	2,000 bbls.	$16 million	Under Constr.	1951	Petrocarbon	Petrocarbon	Petrocarbon
Philblack, Ltd.	Avonmouth, England	Carbon Blk. Plt.	137,000 lbs.	$5 million	Completed	.....	Phillips	H.W.P.	H.W.P.
Raffinerie Belge de Petroles, S.A.	Antwerp, Belg.	Topping Unit	8,000 bbls.	$1,000,000	Contracted	Sept., 1951	.....	H.W.P.	Chaurobel
Raf. Belge	Antwerp, Belg.	Atmos., Vac. Distill.	7,000 bbls.	$1.5 million	Planning	1951	.....	.....	.....
Raffineries Francaises de Petrole de l'Atlantique	St. Nazaire, France	Consolidate Refineries	7,100 bbls.	$9.4 million	.....	.....	.....	Separator-Nobel	.....
*Raffineries Francaises	Paris	Thermal Reformer	.....	.....	Contracted	Jan., 1953	.....	Koch	Koch
Raffinerie Siciliane Olii Minerali, Sp.A.	Augusta, Sicily	Crude Refinery	10,000 bbls.	.....	Under Constr.	1951	U.O.P.	U.O.P., Delta, Staff, Separator-Nobin	Staff
Refineria de Petroleos de Escombreras, SA., (REPESA)	Cartagena, Spain	Four cell induced draft cooling tower	.....	.....	Under Contract	1951	.....	.....	Foster Wheeler
REPESA	Escombreras, Spain	Refinery Atmos. Dist., Lube Plt.	30,000 bbls.	$30 million	Under Constr.	Mid 1953	.....	Foster Wheeler	Foster Wheeler
REPESA	Escombreras	Thermal Reformer: Poly Cat.	6,400 bbls.	$2 million	Contracted	Feb., 1953	U.O.P.	McKee	Staff
REPESA	Cartagena, Spain	Lube Plt.	1½ mil. tons/yr.	.....	Projected	.....	.....	.....	.....
*Ruhrbau, G.M.B.H.	Muelheil, Ruhr	Crude Refinery	4,000 bbls.	.....	Completed	.....	.....	.....	.....
*Ruhrchemie, A.G.	Oberhausen-Holten, Germ.	Crude Refinery	6,000 bbls.	.....	Under Constr.	Mid 1952	.....	Koch	Koch
S.A. Cons. Ref. Pet. em Portugal	Cabo Ruivo Plt., Portugal	Topping Unit	10,000 bbls.	.....	.....	.....	.....	.....	.....
S.A. Cons. Ref. Pet. em Portugal	Cabo Ruivo Plt., Portugal	Cracking Unit	5,000 bbls.	.....	.....	.....	.....	.....	.....
S.A. Cons. Ref. Pet. em Portugal	Cabo Ruivo Plt., Portugal	Reformer	2,500 bbls.	.....	.....	.....	.....	.....	.....
Scottish Oils, Ltd.	Grangemouth, Scotland	Stage I: 1 Pipe Still Distill., Phos. Acid Trtg. Plt. Steam Boil. & Power Plt.	1.5 mln. tons per yr. 30,000 kw.	$32.6 million	Completed	.....	.....	Kellogg	Kellogg
Scottish Oils	Grangemouth, Scotland	Stage II: Cat. Crk., Gas Rec. Vac. Distill., Cat. Poly Plt., & Trtng Plt.	37,700 bbls.	$52 million	Under Constr.	Mid., 1952	.....	.....	.....
Scottish Oils	Grangemouth, Scotland	Buoyancy Foundations	.....	.....	Under Constr.	1951	.....	Rendel Palmer and Tritton	.....
Shell Chemical Mfg. Co., Ltd.	Stanlow, Eng.	Teepol Plant Extension	75,000 tons per year	.....	Under Constr.	Spring, 1952	.....	.....	.....
Shell Refining & Marketing Co., Ltd.	Shell Haven, England	Reforming Unit	†10,000 bbls.	.....	Under Constr.	1951	.....	.....	.....
Shell R. & M.	Shell Haven, England	Feed Prep.	†16,000 bbls.	$34 million	Under Constr.	.....	.....	.....	.....
Shell R. & M.	Stanlow, Eng.	Comprehensive Refining	60,000 bbls.	.....	Under Constr.	Early 1952	.....	.....	.....
Shell Union Oil	France	Wharf, tankage detergent, Acetone-Syn Iso-Propyl Plts	.....	$6 million	Under Constr.	Late 1951	.....	.....	.....
Societe Generale Des Huiles de Petrole	Dunkirk, France	Crude Reform.	33,000 bbls.	$38,105,000	Under Constr.	1951	Lummus, Kellogg	Lummus, Kellogg	Lummus, Kellogg
Societe Generale	Dunkirk, France	Furl. Ref. Sol. Dewax., Wax Fractn.	2,400 bbls.	.....	Under Constr.	1951	Texaco	Lummus	Lummus
Societe Industrial Belge des Petrole	Antwerp, Belg.	Crd. Crk. Ref.	30,000 bbls.	.....	Under Constr.	1951	.....	Kellogg	Kellogg
Societa per l'Industria del Petrolio	La Spezia, Italy	Expansion	20,000 bbls.	.....	Under Constr.	Mid. 1952	.....	.....	.....
Societa per Azioni Raffineria Padana Olii Minerali	Milan, Italy	Refinery	10,000 bbls.	$20 million	Planned	.....	.....	.....	.....
Societe per Azioni Raffineria Padana Olii Minerali	San Martino di Trecate, Italy	Refinery	13,000 bbls.	$15 million	Under Constr.	Fall, 1952	.....	Badger	Badger
Societe Raffinazione Olii Minerali (IROM)	Porto Marghera, Italy	Atmospheric & Vac. Distill., Acid Treat., Contract Filtration for Lube Oils, Electric Gen. Unit, Load Facilities	11,000 bbls.	$6.4 million	Contracted	.....	.....	.....	.....
Socony-Vacuum Francaise	Frontignan, France	T.C.C. Unit	.....	.....	Planning	.....	Socony-Vacuum	.....	.....
Socony-Vacuum Francaise	Notre Dame de Gravenchon	MEK Unit	1,000 bbls.	$6 million	Under Constr.	1951	Texaco	Lummus	Staff
Socony-Vacuum Francaise	Notre Dame de Gravenchon	Grease and Compounding	900 lbs.	.....	Under Constr.	1951	.....	Staff	Staff
Socony-Vacuum Italiana, S.P.A.	Naples, Italy	Visbreaker	.....	.....	.....	1951	.....	Staff	Staff
*South Africa Coal Oil & Gas	Coalbrook, Orange Free St.	Coal Synthesis Plant	3,500 bbls.	$50.4 million	Under Constr.	1955	.....	Kellogg	Kellogg
Stanic Industria Petrolifera	Leghorn, Italy	Ref. Expan.	13,000 bbls.	.....	.....	End 1952	.....	.....	.....

REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

COMPANY	Plant Site	Project	Daily Capacity	Estimated Cost	Status	Probable Completion	Licensor	Engineering	Contractor
Stanic Ind. Pet.	Bari, Italy	Modernization	12,000 bbls.			1952			
Standard Francaise des Petroles	Port Jerome, France	Dewaxing Plant	1,200 bbls.	$6.4 million	Design	End 1951		S.O.D.	Foster Wheeler
Standard Francaise des Petroles	Port Jerome, France	Desophalting Plant	1,800 bbls.		Design	End 1951		S.O.D.	
Standard Francaise des Petroles	Port Jerome, France	Cat. Crk.	10,000 bbls.	$10 million	Authorized	March, 1953			
Standard Oil (N.J.)	Belgium	Dist. Crack	23,000 bbls.		Planned	Early 1952			Foster Wheeler
Standard-Vacuum Ref. of South Africa	Wentworth, Durban, Union of S. Africa	Refinery	10,000 bbls.	$12.3 million	Planning	Late 1953			
Trent Oil Prod. Development Co.	North Shields, England	Crude Plant	11,500 bbls.	$4.8 million	Plans approved				
Union Petrol Refinery, Ltd.	Johannesburg, Union of South Afrion	New Refinery		$20 million	Projected				
Vacuum Oil Co., Ltd.	London, Eng.	Oil Refinery	0.3 mln. bbls./yr.	$35 million	Planning				
Vacuum Oil Co., Ltd.	Birkenhead, England	Grease Plt.		$1 million	Contracted	Early 1952		H.W.P.	H.W.P.
Vacuum Oil Co.	Coryton, Eng.	Lube Refinery	17,000 bbls.	$20 million	Under Constr.	Sept., 1952			
Near East									
Anglo-Iranian	Abadan, Iran	Cat. Cracker	30,000 bbls.		Completed			Foster Wheeler	Foster Wheeler
Anglo-Iranian	Abadan, Iran	Gas Recov., Stab.	22,000 mcf		Completed			Badger	Badger
Arabian American Oil Co.	Abqaiq, Saudi Arabia	Crude Oil Stabiliser	300,000 bbls.	$4.8 million	Completed			Staff and Fluor	Fluor, Middle East, S.A.
Consolidated Ref., Ltd.	Haifa, Palestine	Gen. Facilities Conversion of Kellogg Comb-Top. and Crk.	35,000 bbls.		Planned	1951		Badger	
Iraq Government	Baghdad Area	Refinery	24,000 bbls.	$19.6 million	Planning	Spring, 1954		Kellogg	
Turkey Government	Ramandag Field	Refinery	3,000 bbls.	$5.5 million	Planning				
Far East									
Batavsche Pet. Mij. (Shell)	Balikpapan, Borneo, East Indies	Expansion	80,000 bbls.		Under Constr.	1951			
Batavsche Pet. Mij.	Pladjoe, Sumatra	Rehad. to Comprehensive Refg.	71,000 bbls.		Under Constr.	Early 1952			
Batavsche Pet. Mij.	Tjepu, Java	Rebuild TEL Blending Unit & Dist. Unit			Planning				
Burmah Oil Co., Ltd.	Syriam, Burma	Furf. Sol. Dewax., Wax Mfg.	1,000 bbls.	$600,000	Designing		Texaco	Badger	
*Burmah Oil (Rangoon)	Chaukfield, Central Burma	2 Stage Distillation & Related Fac.			Under Shipmt.	Oct., 1953			
KOA Oil Co., Ltd. (and) Caltex Oil Co., Ltd	Marifu, Japan	Expansion of Vac. Unit, Contact Rerun Unit	Restricted to 3,000 BPCD		Under Constr.	1951		Tatsumi	Tatsumi
Kon Oil Co., Ltd.	Marifu, Japan	Solvent Dewaxing Plt.; Solvent Extracting Plt.			Design	1951-1952			
Mitsubishi Oil Co., Ltd.	Tokyo, Japan	Vacuum Distillation Unit	2,000 bbls.			1951			
Mitsubishi Oil	Tokyo, Japan	Solvent Extraction & Dewaxing Processes				1951			
Nippon Oil Co., Ltd.	Yokohama, Japan	Benzene-Ketone Dewaxing-Deoiling Unit							
Nippon Oil	Kudamatsu, Japan	Benzene-Ketone Dewaxing-Deoiling Unit							
Nippon Oil	Japan	Lube Oil Refining			Under Constr.			Separator-Nobels	
*Toa Nenryo Kogyo K. K.	Wakayama, Japan	Propane, Dewaxing	1,200 bbls.		Under Constr.	Oct., 1952		S.O.D.-Staff	Staff
T. N. K.	Wakayama	Phenol Ext.	1,720 bbls.		Under Constr.	Oct., 1952		S.O.D.-Staff	Staff
T. N. K.	Wakayama	Vac. Distill.	4,700 bbls.		Completed			S.O.D.-Staff	Staff
T. N. K.	Wakayama	Wax Plt.	900 bbls.		Completed			S.O.D.-Staff	Staff
T. N. K.	Wakayama	Propane Deasphalting	500 bbls.		Completed				
T. N. K.	Wakayama	Topping Plt.	10,000 bbls.		Completed			Staff	Staff
Oceania									
*Australian Shell	Clyde, New South Wales	LVI Lube Oil	250 bbls.	$620,000	Under Constr.	Sept., 1951			
Australian Shell Oil Co.	Geelong, Victoria, Australia	New Refinery	16,000 bbls.	$4.8 million	Under Consid.	Late 1954			
Australian Shell	Geelong, Victoria, Australia	Bitumen and Luboil Plant		$10 million	Projected	Late 1953			
Australian Shell	Geelong, Victoria, Australia	Asphalt, Lube Sol. Extct Plt.			Projected	Late 1953			
*Australian Shell	Melbourne, Australia	New Refinery	22,000 bbls.		Under Constr.	Fall, 1953			

* First appearance in tabulation. † Added capacity.

NOTE: Austin—Austin Co. Badger—E. B. Badger & Sons. Barnes—W. M. Barnes & Co. Betchel—Betchel Corp. Blaw-Knox—Blaw-Knox Construction Co. Braun—C. F. Braun Co. Breda—Breda Co. of Milan. Brown & Root—Brown & Root Construction Co. Cabot Eng.—Cabot Engineering. Can Kellogg—Canadian Kellogg Co. Cat Constr.—Catalytic Construction Co. Chemico—Chemical Construction Co. C. B. & I.—Chicago Bridge & Iron Works Co. Conoco—Continental Oil Co. Delta—Delta Engineering Corp. Dresser—Dresser Engineering Corp. Ebasco—Ebasco Services, Inc. E & A—Ehrhart & Arthur, Inc. Esso Eng—Esso Engineering Corp. Fletcher—Fletcher Oil Co. Fluor—Fluor Corp. Foster Wheeler—Foster Wheeler Corp. Graff—Graff Engineering & Equipment Co. Grebe & Doremus—Grebe & Doremus Process Co. Houdry—Houdry Corp. Huber—J. M. Huber Corporation Hudson—Hudson Engineering Corp. H. W. P.—Head Wrightson Process, Ltd. Hydrocarbon—Hydrocarbon Research, Inc. J. & L.—Jones & Laughlin Supply Co. Kellogg—The M. W. Kellogg Co. Kellogg P. A.—Kellogg Pan-American. Koch—Koch Engineering Co. Koppers—Koppers Co., Inc. Knowles—Morris Knowles & Co. Lummus—The Lummus Co. McKee—Arthur G. McKee Co. O. L. Olson. P. A. Hydro Eng.—Pan American Hydrocarbon Research Co. Parsons—The Ralph M. Parsons Co. Perco—Div. Phillips Petroleum. Petco—Petroleum Engineering Tool Co. Petrocarbon—Petrocarbon Ltd. Phillips—Phillips Petroleum Co. Pioneer—Pioneer Industrial Co. Pritchard—J. H. Pritchard Co. Pro Eng—Process Engineers, Inc. Process Constr—Process Construction Co. Ref Eng—Refinery Engineering Co. Ref Maint—Refinery Maintenance Co., Inc. Schneider—Schneider & Cie. Socony-Vac—Socony Vacuum Oil Co. SOD—Standard Oil Development Co. Stearns-Roger—Stearns-Roger Manufacturing Co. Stone & Webster—Stone & Webster Construction Co. Sunland—Sunland Refining Co. Swco—Southwestern Engineering Co. Tatsumi—Tatsumi Engineering Co. Tellepsen—Tellepsen Construction Co. Texaco—The Texas Co. UOP—Universal Oil Products Co. Walker—P. J. Walker Co.

SERVICE LEDGER
1901-1951

- ANGLO-IRANIAN OIL CO. LTD.
- ARGENTINE GOVERNMENT OIL FIELDS
- ARGENTINE MINISTRY OF WAR
- ATLANTIC REFINING CO.
- ATOMIC ENERGY COMMISSION
- BRITISH AMERICAN OIL CO. LTD.
- CANADIAN OIL REFINERIES, LTD.
- CALIFORNIA REFINING CO.
- CHAMPLIN REFINING CO.
- CIE. DE RAFFINAGE SHELL-BERRE
- CIE. FRANCAISE DE RAFFINAGE
- CIE. INDUSTRIELLE DES PETROLES
- CITIES SERVICE OIL CO.
- CITIES SERVICE REFINING CORP.
- COLGATE-PALMOLIVE-PEET
- CONSOLIDATED REFINERIES, LTD.
- CONTINENTAL OIL CO.
- CORY BROTHERS & CO., LTD.
- CREOLE PETROLEUM CORP.
- DIAKEL CORPORATION
- EL DORADO REFINING CO.
- ESSO STANDARD OIL CO.
- GENERAL PETROLEUM CORP. OF CALIFORNIA
- GLOBE OIL & REFINING CO.
- GULF OIL CORP.
- HUMBLE OIL & REFINING CO.
- IMPERIAL CHEMICAL INDUSTRIES
- IMPERIAL OIL LTD.
- KANOTEX REFINING CO.
- KENDALL REFINING CO.
- LEVER BROS.
- LION OIL CO.
- MAGNOLIA PETROLEUM CO.
- MARINE OIL REFINERS OF AFRICA, LTD.
- MATHIESON CHEMICAL CORP.
- McCOLL-FRONTENAC OIL CO., LTD.
- MID-CONTINENT PETROLEUM CORP.
- MITSUBISHI OIL CO., LTD.
- NATIONAL PETROLEUM COUNCIL OF BRAZIL
- PAN AMERICAN REFINING CORP.
- PENNZOIL CO.
- PHILLIPS PETROLEUM CO.
- POLYMER CORP., LTD.
- PURE OIL CO.
- SHELL CHEMICAL CORP.
- SHELL OIL CO.
- SHERWIN-WILLIAMS CO.
- SINCLAIR REFINING CO.
- SKELLY OIL CO.
- SOCIETE DES RAFFINERIES DE PETROLE DE LA GIRONDE
- SOCIETE GENERALE DES HUILES DE PETROLE
- SOCIETE INDUSTRIELLE BELGE DES PETROLES
- SOCONY-VACUUM FRANCAISE
- SOCONY-VACUUM OIL CO.
- E. R. SQUIBB & SONS
- STANDARD OIL CO. (INDIANA)
- STANDARD OIL CO. (OHIO)
- STANDARD OIL CO. OF CALIFORNIA
- SWIFT AND CO.
- TEXAS CO.
- UNION OIL CO. OF CALIFORNIA
- UTAH OIL REFINING CO.
- WASATCH OIL CO.
- WOOD RIVER OIL & REFINING CO.

From pipe stills to fluid cats...with Jersey!

Various Jersey Standard affiliates have been on Kellogg's customer ledger for twenty-five years. In that time, Kellogg has built a score and more of process units for the New Jersey, Maryland, Louisiana and Aruba refineries of Jersey affiliates.

Process development also found these two companies working along the same paths, a fact which culminated in Kellogg being entrusted with the erection of the world's first Fluid catalytic cracker...in 1941 at Esso Standard Oil Company's Baton Rouge Refinery.

In the last decade, following this historic development, Kellogg has erected for Jersey Standard and its affiliates —seven more Fluid "cats", the largest hydroformer in the world, a hydrogenation unit, combination thermal units, delayed coker, thermal reformers and propane and phenol processing plants... on three continents...units capable of processing almost 500,000 BPD of petroleum products.

THE M. W. KELLOGG COMPANY

A SUBSIDIARY OF PULLMAN INCORPORATED

for fifty years an integral part of processing history

NEW YORK JERSEY CITY LOS ANGELES TULSA HOUSTON TORONTO LONDON PARIS

M.W. KELLOGG CO. PAID 1951

Portrait at

This year is Kellogg's fiftieth of service to industry. At this time naturally, as a group of men—known collectively to the modern business world as The M. W. Kellogg Company—we can think back nostalgically. We can remember the chimney stacks

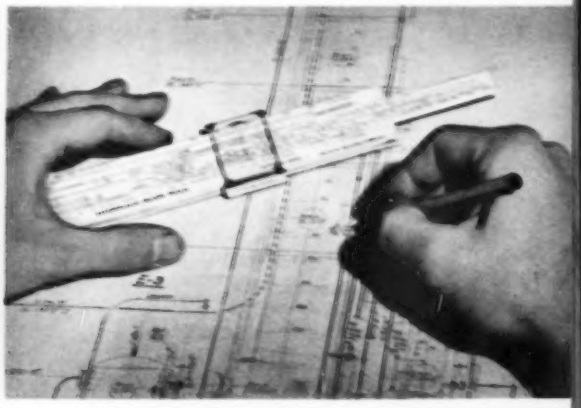
"Getting the Most out of Talent"

Preceding camera "portraits" of M. W. Kellogg today, appearing in this publication, have guided the regular reader through the major research and development phases of Kellogg operation, through Process Engineering, and through the basic steps of Design Engineering.

This month, the camera focuses on a few of the many special groups and unique devices that Kellogg utilizes to make the efforts of its design engineers more efficient.

1. *FOR EVERY SPECIFIC PHASE* of design engineering there is a complete matching group of specializing engineers. This view of a section of the *Heat Transfer Division* shows only the "figure men"—engineers specifying type of exchangers and general design limitations. Detail engineering is done elsewhere. Another group handles design of electrical systems and instrumentation exclusively.

4. *USUALLY ASSOCIATED* with wages, hours and cost accounting, these modern punch card machines serve the engineering departments in a slightly different manner. Through keeping continuous records of engineering time "by *type* of job" rather than "by job", realistic budgets are achieved of engineering time required to perform any of the hundreds of engineering tasks comprising a refinery project.



5. *BUT MAN AND BRAIN POWER* to do these supporting tasks, that make design engineers more efficient, are not the only "extras" present in the organization. Specialized and unique tools are created and made available to design engineers. This slide rule was created by Kellogg engineers to speed up the computation of vapor and liquid flow through process piping of various diameters under varying operating conditions.

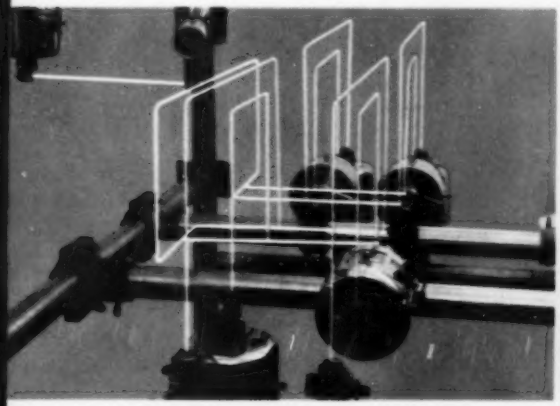
Fifty... no. 6

KELLOGG
1901-1951
50th Anniversary

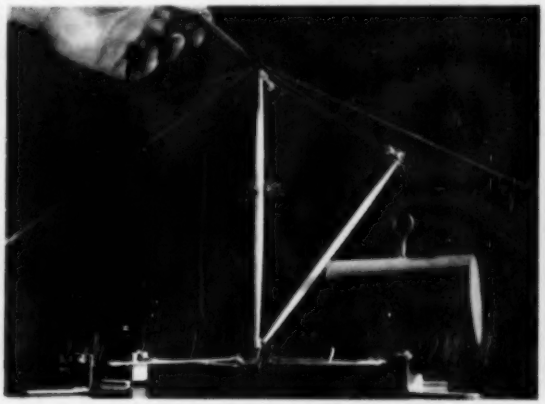
we built in 1901 . . . the first crude vessels for oil refiners in the 'teens . . . our first combination unit. The forty-odd Fluid cat crackers built in these years. But, after all, The M. W. Kellogg Company is only a factor as it is able to serve industry today. For that reason, we are presenting this series of monthly camera studies which document our belief that a truly integrated organization can better serve industry to achieve greater earning power. This is No. 6 in the series.

2. *AS REPLETE WITH DESIGN* engineering talent as Kellogg is, the organization's abilities are equally dependent on many other technicians. Of major importance among these is the *Estimating Engineering Staff*. Besides estimating costs of new projects, this group serves refiners through its trend charts of the major cost ingredients of refinery projects. These pinpoint for design engineers the best potentials for economies.

3. *CLOSELY ALLIED TO ESTIMATING* is the engineering job of *Scheduling*—not only of the engineering work itself, but of purchasing, fabrication and construction as well. Experience of Kellogg's scheduling personnel is measured in decades. This experience stands customers in good stead in the setting up of realistic schedules for completion of a project at the earliest possible date consistent with expenditure limitations.



6. *THIS MODEL TESTER* for piping systems employs special Kellogg-conceived electrical measuring heads. The device permits the rapid and accurate calculation of pipe stress problems in a matter of minutes . . . problems which would otherwise involve the solution of as many as 50 to 60 simultaneous equations, virtually "impossible" mathematically from the standpoint of time consumption.



7. *ANOTHER SPECIAL AID* is this guy derrick model equipped with strain gauges. This tool permits engineers, in making plot plans and issuing field fabrication instructions, to check *in advance* the exact methods required to lift vessels safely into position. There are perhaps a score of such useful "gadgets" scattered about the engineering floors. Of course, they save hours of time, but, much more important, they permit true accuracy in planning.

NEXT MONTH

. . . in the seventh in this series of camera studies of M. W. Kellogg today . . . you will review the important role that Technical Data and Standards play in the engineering and procurement functions.

Toughness built in for a tough exchange job!

M. W. KELLOGG

This 8 foot diameter tube sheet is for a recycle-catalyst cooler on a giant cat-cracker. Tons of erosive powder will pour through the cooler's tubes in minutes as it controls regenerated catalyst temperature. Kellogg's exclusive fabricating techniques really pay off in equipment for such tough processing jobs.

Pressure Vessels
Vacuum Vessels
Fractionating Columns
Drums and Shells
Heat Exchangers
Process Piping
Hi-pressure—Hi-temp Power Piping
Bends and Headers
Giant One-Piece Bends
Forged and Welded Fittings
Radial Brick Chimneys

Continuing Basic Study of heat exchange by Kellogg development groups over 20 years has produced unduplicated design data.

Shop Layout Craftsmen have had experience on all types of heat exchangers, from marine condensers to jet engine combustion-chambers.

Rigid Quality Control is maintained by inspectors reporting directly to *Shop Management* rather than to *Production* executives.

Extensive Shop Facilities, from plate forming to stud threading, permit *complete* fabrication of any type heat exchanger.

Special Shop Techniques—the component parts of each exchanger are fabricated as a production unit, building in the advantages of "tailor-made" fit.

NEWS FOR OPERATORS IN WESTERN CANADA!

The Canadian Kellogg Company Ltd. has established complete shop facilities for the fabrication of all types of piping at EDMONTON, Alberta. Inquire directly or through any Kellogg or Canadian Kellogg office.

The M. W. Kellogg Company *(A Subsidiary of Pullman Incorporated)* **New York, Jersey City, Los Angeles, Tulsa, Houston, Toronto, London, Paris**

β,β′-oxydipropionitrile (ODPN) is a highly selective solvent and may be used, in conjunction with a paraffin, to separate a variety of organic compounds by liquid-liquid fractional extraction. Distribution coefficients of various aromatic compounds between ODPN and a paraffin hydrocarbon are tabulated. Rules are given for the extension of these data to compounds not listed.

PETROLEUM
REFINER
JULY, 1951

Aromatics Recovery By Solvent Refining

β,β′-oxydipropionitrile as a Selective Solvent

E. C. MEDCALF, A. G. HILL, and G. N. VRIENS
Calco Chemical Division, American Cyanamid Company
Bound Brook, N. J.

THE use of selective solvents by the chemical industry for extractive separations is well known and has increased steadily in recent years.[3] Examples are the removal of aromatics from lubricating oil stocks with furfural[6] and the extraction of pyridine from water with benzene. A relatively new development is the separation of chemically similar compounds by fractional extraction between two solvents, such as the partition of ethyl and isopropyl alcohols between xylene and water and the distribution of o- and p-nitrochlorobenzenes between heptane and methanol.[9]

Saunders[8] has shown the high selectivity for aromatic hydrocarbons over paraffins exhibited by nitriles, especially β,β′-oxydipropionitrile, β,β′-iminodipropionitrile, and β,β′-thiodipropionitrile. The work reported here shows that β,β′-oxydipropionitrile, hereafter referred to as "ODPN," also exhibits a selectivity between aromatic compounds which have different carbon-hydrogen ratios, contain different substituents, or show position isomerism. Distribution coefficients of various substituted aromatics, between ODPN and a paraffin hydrocarbon, have been obtained and indicate the potential usefulness of such a system in effecting separations by fractional extraction. A number of examples of single-stage separations are also presented, which indicate that these distribution coefficients may be used to predict actual separation factors. Subsequent papers will deal with the results of some multistage extractions carried out with ODPN as a solvent.

Properties of ODPN

Physical and Chemical Properties

ODPN has the following chemical structure:

$$N \equiv C - CH_2 - CH_2 - O - CH_2 - CH_2 - C \equiv N$$

Its important physical constants are given in Table 1,[1] together with those of the corresponding imino and thio compounds. These solvents show the usual nitrile reactions, such as hydrolysis in the presence of strong acids and bases. ODPN is thermally unstable, yielding acrylonitrile and water, at temperatures above 175° C.

Solvent Properties

One of the outstanding characteristics of ODPN is its extreme immiscibility with paraffin hydrocarbons, the mutual solubilities being about 0.1 percent. Saunders[8] has shown the unusually large two-phase area of a ternary phase diagram involving ODPN, a paraffin, and an aromatic. This gives ODPN a marked advantage over a solvent such as furfural for the production of relatively pure aromatic hydrocarbons. An extract of at least 94 percent benzene may be obtained in a single contact from a benzene-heptane mixture containing from 10 to 80 percent benzene. The concentration of

TABLE 1
Physical Properties of Solvents

Property	β,β′-Oxydipropionitrile (ODPN)	β,β′-Iminodipropionitrile	β,β′-Thiodipropionitrile
Appearance	Colorless Liquid	Colorless Liquid	White Crystals
Molecular weight	124.14	123.16	142.20
Melting point (±0.05° C.)	−36.30	−5.50	α28.65 β22.10
Boiling point (1mm.)	120	140	.....
Boiling point (5mm.)	155	162	.....
pH of 10 percent aq. soln.	.....	8.9	.....
Density, 30° C.	1.0405	1.0165	1.1095
Viscosity, cp., 30° C.	8.00	2.85	30.58
Surface tension dynes/cm., 30° C.	47.5	47.7	51.9
Refractive index n_D^{30}	1.4392	1.4422	1.5022 (30°)
Flash point, Tagliabue (Closed Cup)	>176° F.	>176° F.	>176° F.
Solubility in water, 25° C.	10% (∞, 64° C.)	∞	1—2 percent

TABLE 2
Comparison of Selective Solvents

SOLVENT	Solubility of n-Heptane in (Weight Fract.)	Dist. Coeff. of Naphthalene*	Separation Factor
Furfural	.061	0.74	17
Dimethylformamide	.112	0.40	22
β,β'-Oxydipropionitrile	.001	1.7	590

*Conc. in Paraffin (Weight Percent) / Conc. in Solvent (Weight Percent)

benzene in the ODPN, over the range studied, has little effect on the paraffin to benzene ratio in the extract.

In order to illustrate the selectivity of ODPN for aromatic hydrocarbons over paraffins, relative to that of certain other solvents, the solubility of n-heptane in the solvent and the distribution coefficient of naphthalene between n-heptane and the solvent were determined and are shown in Table 2. The separation factor, β, for two compounds, A and B, distributed between two phases, I and II, in equilibrium is given by Equation 1.

$$\beta = \frac{(\text{Conc. of A in I})(\text{Conc. of B in II})}{(\text{Conc. of A in II})(\text{Conc. of B in I})} \quad (1)$$

This general expression holds equally well for the case where the compounds A and B are partitioned between two solvents and the case where only one solvent is used, the second phase consisting of a mixture of A and B. If compound A is a paraffin, compound B, an aromatic, phase I, a mixture of A and B, and phase II, the solvent, then the second factors in the numerator and denominator of Equation 1 represent the reciprocal of the distribution coefficient of the aromatic between the paraffin and solvent. The first factor in the numerator will be close to unity for low concentrations of aromatic, while the first factor in the denominator represents the solubility of paraffin in the solvent. Hence, the separation factor in Table 2 was obtained by taking the reciprocal of the product of the second and third columns and represents a limiting value at low concentrations of naphthalene. This is a convenient basis for comparison and shows that the relatively high selectivity of ODPN is due to its unusually low solvent power for paraffins.

It has been found, however, that the selectivity of ODPN is not limited to aromatic hydrocarbons over paraffins, but that this solvent also differentiates between various substituted aromatic and conjugated heterocyclic compounds. For example, if a mixture of mono-t-butyl-p-cresol and di-t-butyl-p-cresol is treated with the solvent, the monobutylcresol will be largely dissolved while the dibutylcresol is precipitated as a solid.

The high order of selectivity shown by ODPN for many systems, combined with its nearly complete immiscibility with paraffins, made the ODPN-paraffin system a logical one to investigate for use in making separations by fractional extraction. Hence, determinations were made of the distribution coefficients of a number of aromatic compounds between a paraffin hydrocarbon and ODPN. n-Heptane was normally used although it was found that the value of the distribution coefficient was independent of the particular paraffin provided the concentrations were expressed in percent by weight.

Experimental Procedure

The procedure used in determining the distribution coefficients consisted in weighing out 50 grams each of ODPN and n-heptane into a 250-ml. separatory funnel. Five to six grams of the aromatic solute was then accurately weighed into the funnel by means of a weighing pipet. The mixture was vigorously shaken at room temperature and allowed to settle for at least one hour. The layers settled very quickly and in no case was the formation of an emulsion noted.

After separation, each layer was analyzed by determining its refractive index and comparing with that of a known mixture. Material balances on the solute had an average error of about 2.5 percent. In the case of some of the pyridine derivatives, analyses were by titration, and the error was still less. Certain of the aromatic hydrocarbons were determined in the solvent phase by adding 50 grams of heptane, 125 ml. of water, and heating to about 70° C., whereupon the water and solvent layers became miscible and the aromatic hydrocarbon was transferred practically quantitatively to the heptane layer. This was separated while hot and analyzed by refractive index, thus necessitating only one known refractive index curve for the analysis of both phases of the original mixture. The distribution coefficient was calculated by dividing the concentration of solute in the paraffin layer by its concentration in the solvent phase, both expressed as percent by weight.

The n-heptane used was research grade material and had a refractive index, $n_D^{20} = 1.3880$. The ODPN was purified by vacuum distillation and had a refractive index, $n_D^{20} = 1.4420$. An indication of the purity of each solute is given in the tables by its refractive index or, where appropriate, its freezing point.

Results

The first class of compounds studied were the aromatic hydrocarbons and their alkylated derivatives. Distribution data for these are shown in Table 3. It may be seen that the effect of adding a methyl group to an aromatic ring or side chain is to multiply the distribution coefficient by a factor of 1.6 ± 0.2. The ortho substituted aromatic hydrocarbons appear to have a definitely lower coefficient than the corresponding meta and para derivatives. This effect is illustrated by the xylenes, mesitylene and pseudocumene, and the methyl-naphthalenes. A comparison of styrene with ethylbenzene shows the pronounced lowering of the distribution coefficient caused by unsaturation in the side chain.

Table 4 gives the results with alkylated pyridines. The value for β-picoline may be slightly high due to the presence of traces of 2,6-lutidine. It was purified from a 145° tar base cut

TABLE 3
Distribution of Aromatic Hydrocarbons

Compound	Purity (n_D^{20} or F. P.)	Distribution Coefficient*
Benzene	1.5010	2.3
Toluene	1.4957	3.6
o-Xylene	1.5027	5.2
m-Xylene	1.4975	6.0
p-Xylene	1.4933	6.0
Ethylbenzene	1.4960	6.0
Styrene	1.5470	2.8
Mesitylene	1.4916	11
Cumene	1.4926	11
Pseudocumene	1.4921	9.2
Tetralin	1.5414	8.4
Naphthalene	80.3° C.	1.7
α-Methylnaphthalene	1.6115	2.6
β-Methylnaphthalene	34.3° C.	2.8

*Conc. in Paraffin (Weight Percent) / Conc. in ODPN (Weight Percent)

TABLE 4
Distribution of Pyridine Derivatives

Compound	Purity (n_D^{20} or F. P.)	Distribution Coefficient*
Pyridine	1.5090	0.35
α-Picoline	1.5000	0.72
β-Picoline	1.5042	0.67
γ-Picoline	1.5028	0.62
2,4-Lutidine	1.5006	1.0
2,6-Lutidine	1.4986	1.6
2,5-Methylethylpyridine	1.5014	1.6
Quinoline	1.6258	0.35
Isoquinoline	22.6° C.	0.33
Quinaldine	1.6086	0.69

*Conc. in Paraffin (Weight Percent) / Conc. in ODPN (Weight Percent)

TABLE 5
Distribution of Alkylated Anilines

Compound	Purity (n_D^{25} or F. P.)	Distribution Coefficient*
Aniline	1.5837	0.06
o-Toluidine	1.5730	0.08
p-Toluidine	43.7° C.	0.08
2,4-Xylidine	1.5590	0.15
2,5-Xylidine	1.5593	0.17
p-Ethylaniline	1.5544	0.12
Mesidine	1.5520	0.42
α-Naphthylamine	48.0° C.	0.03
Methylaniline	1.5730	0.22
Ethylaniline	1.5548	0.30
Ethyl-o-toluidine	1.5465	1.0
Methyl-p-toluidine	1.5575	0.38
Ethyl-α-naphthylamine	1.6455	0.32
Dimethylaniline	1.5588	1.4
Diethylaniline	1.5423	3.6
Ethylbenzylaniline	1.5953	1.6
Dimethyl-o-toluidine	1.5270	6.5
Diethyl-o-toluidine	1.5069	20
Dimethyl-p-toluidine	1.5428	2.6
Diethyl-α-naphthylamine	1.5620	9.4

*Conc. in Paraffin (Weight Percent) / Conc. in ODPN (Weight Percent)

by a single application of acetic and phthalic anhydrides, according to the method of Riethof, *et. al.*,[7] and probably should give a coefficient close to that of γ-picoline. Differences caused by the presence of alkyl substituents alpha to the nitrogen are readily apparent in the distribution coefficients of the picolines and quinolines. The introduction of a second methyl group alpha to the nitrogen, as in 2,6-lutidine, has an effect equivalent to an ethyl group in the beta position, as in 2,5-methylethylpyridine. These differences may be caused by steric effects, such as a hindering of the approach of solvent molecules to the nitrogen atom by the presence of methyl groups in the alpha position.

The distribution coefficients of various alkylated anilines are shown in Table 5. Again the effect of ortho substitution is marked, especially when the nitrogen is also alkylated. For example, the distribution coefficient of dimethyl-o-toluidine is 2.5 times that of dimethyl-p-toluidine. The introduction of a second ortho group, as in mesidine, has a greater effect than the first one. Probably not only do ortho alkyl groups partially block the approach of solvent molecules to the nitrogen atom, but they also interfere with its rotation when alkyl groups are attached. As might be expected, the addition of a methyl group to the nitrogen has, in general, a greater effect on the distribution coefficient than its addition to the ring or to an alkyl group.

In Table 6, the distribution coefficients of several hydroxy, chloro, and nitro substituted aromatics are listed. The eighty-fold increase in the coefficient of di-t-butyl-p-cresol over mono-t-butyl-p-cresol is probably due to a "hindering" of the hydroxyl group by the adjacent butyl groups. A similar ortho effect was noted in the case of the xylenols by Golumbic, et al., who studied the partition of the lower alkyl phenols between cyclohexane and water.[5]

A single chlorine atom does not appear to change the distribution coefficient of an aromatic appreciably unless it is ortho to an alkyl group, as in o-chlorotoluene, in which case the coefficient is raised. However, a second chlorine substituent increases the value of the coefficient. The striking difference between ortho nitrochloro compounds and the corresponding meta and para derivatives is illustrated by the nitrochlorobenzenes and toluenes.

Correlation of Data

In attempting to correlate the changes in distribution coefficients, with changes in structure, it would be highly desirable to be able to break each coefficient down into the individual activity coefficients in the two phases. Unfortunately, there are insufficient data in the literature to permit a calculation of the activity of a large number of the solutes in paraffin hydrocarbons. However, a number of qualitative conclusions may be drawn. The activity coefficients of aromatic hydrocarbons in paraffins are comparatively near unity, as shown by the value of 1.3 for low concentrations of toluene in n-heptane.[10] Hence, the factor of 1.6, by which a given distribution coefficient must be multiplied to obtain the value for the next higher homolog, is due to a corresponding change in the value of the activity coefficient of the solute in ODPN. This large change on the addition of a single methyl group must be closely related to the extreme phobia for paraffinic compounds exhibited by ODPN.

Francis[4] gives the critical solution temperatures of a number of aromatic amines in n-heptane. It is evident from the lowering of the cst. (critical solution temperature) that the change in

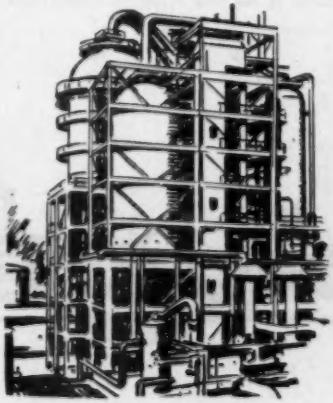


TABLE 6
Distribution of Miscellaneous Substituted Aromatics

Compound	Purity (n_D^{25} or F. P.)	Distribution Coefficient*
t-Butyl-p-cresol	51.2° C.	0.14
Di-t-butyl-p-cresol	68.6° C.	11
p-Dodecyl phenol	1.5058	3.8
Chlorobenzene	1.5248	2.6
o-Chlorotoluene	1.5260	5.6
p-Chlorotoluene	1.5210	3.4
m-Dichlorobenzene	1.5468	4.3
o-Nitrochlorobenzene	32.1° C.	0.15
p-Nitrochlorobenzene	82.9° C.	0.30
2,4-Nitrochlorotoluene	1.5580	0.29
2,4-Nitrochlorotoluene	36.0° C.	0.68

*Conc. in Paraffin (Weight Percent) / Conc. in ODPN (Weight Percent)

distribution coefficient on ring alkylation of aniline is due to a change in the activity coefficient in the heptane as well as in the solvent phase. However, the fact that the activity coefficient of methylaniline in heptane, as shown by the cst., lies between those of toluidine and xylidine indicates that the large increase in the distribution coefficient from aniline to methylaniline is due primarily to a correspondingly large change in the activity coefficient in the ODPN phase. It may be inferred from the foregoing discussion that many of the observed variations in the distribution coefficients among chemically similar compounds follow largely from corresponding variations in their activity coefficients in ODPN.

The following generalizations have been drawn from the distribution coefficients given in Tables 3 to 6:

1) The effect of adding a methyl group to an aromatic ring or a side chain is to multiply the distribution coefficient by a factor of about 1.6.

2) Ortho alkylated aromatic hydrocarbons have a lower distribution coefficient than the corresponding meta and para derivatives.

3) The presence of a double bond in an alkyl side chain lowers the distribution coefficient by a factor of about 2.

4) Alkyl groups ortho to an aromatic amino group, aromatic hydroxyl group, or heterocyclic nitrogen cause an abnormally large increase in the distribution coefficient.

5) Alkyl groups on an aromatic amino group cause a greater increase in the distribution coefficient than alkyl groups on the ring.

6) Monochlorinated aromatics have distribution coefficients similar to those of the parent compounds, except when the chlorine is ortho to an alkyl group, in which case the coefficient is higher.

7) Ortho nitrochloroaromatics have distribution coefficients equal to about one-half those of the corresponding meta and para derivatives.

TABLE 7
Single-Stage Separations

A	B	COMPOSITION, (Weight Percent A)			Separation Factor	
		Feed	ODPN Product	Heptane Product	Observed	Predicted
Benzene	Mesitylene	49	67	36	3.6	4.8
Methylaniline	Dimethylaniline	47	64	27	4.8	6.4
γ-Picoline	2,6-Lutidine	52	67	38	3.2	2.6

Applications

Two recent papers[2,9] have emphasized the utility of fractional extraction for the separation of materials which are close-boiling, form azeotropes, are thermally unstable, or for some other reason cannot be separated by distillation. The separation factor in fractional extraction operations, given in Equation 1, is equal to the ratio of the distribution coefficients of the compounds being separated and is analogous to relative volatility in the case of fractional distillation. Of the classes of compounds studied, the aromatic hydrocarbons show the least applicability to fractional extraction between ODPN and a paraffin, as their separation factors by extraction are usually smaller than those by distillation. An important exception is the case of ethylbenzene and styrene, which have a separation factor by extraction of 2.1 and a relative volatility of 1.3. A simple calculation will show that only about one-third as many theoretical stages would be required for separation of these materials by extraction as by distillation.

Pyridine and aniline derivatives, on the other hand, are frequently almost impossible to separate by distillation. For example, β- and γ-picoline and 2,6-lutidine all boil within a 1° range. Yet by fractional extraction with ODPN, it is relatively easy to separate the 2,6-lutidine from the picolines, the separation factor being about 2.6. p-Ethyl- and N,N-diethylaniline have almost identical boiling points and show a separation factor of 30 by extraction, and monomethyl- and dimethylaniline, which boil only 2° apart at 760 mm., have a separation factor by extraction of 6.4.

ODPN-paraffin systems also show promise for the separation of isomers. The 3,4- and 2,4-nitrochlorotoluenes and the o- and p-nitrochlorobenzenes each have about a 3° difference in boiling points and yet show separation factors by extraction of 1.65 and 2.0 respectively. It appears to be generally true that ortho substituted aromatics show distinct differences in their distribution coefficients from the corresponding meta and para derivatives.

It should be noted that the distribution coefficients of two solutes in the presence of one another will not necessarily be the same as those obtained individually, and, in general, the observed separation factor will be somewhat different from that predicted from the individually determined coefficients. Single-stage separations were made for several of the examples previously cited, and it was found that the predicted separation factors gave a good indication of the observed results. Table 7 gives the results of these experiments, in which a weighed quantity of a known mixture of the materials to be separated was distributed between ODPN and heptane in a separatory funnel. The total solute in each phase was determined by its refractive index and the heptane layer was analyzed for each component by distillation in the case of benzene-mesitylene and by infrared in the case of the other two examples.

One problem encountered in making separations with ODPN is the fact that dissolved materials cannot usually be separated from the solvent by distillation due to its high boiling point and thermal instability. This has been solved by making use of one of several extraction techniques. The solvent may be directly extracted with a paraffin to remove the solute, or it may be diluted with water at a temperature above that of complete miscibility (64° C.) and then extracted with a paraffin. The water will tend to force the solute into the paraffin and the solvent may be recovered by cooling and separating from the water, which is then recycled. In either case the solute may be recovered from the paraffin by distillation.

Summary

β,β′-oxydipropionitrile possesses unusually selective solvent properties which make it suitable for the extraction of a high purity aromatic fraction from a hydrocarbon mixture. This same high selectivity makes the ODPN-paraffin system an ideal medium for effecting separations of a wide variety of organic compounds by fractional extraction between two solvents.

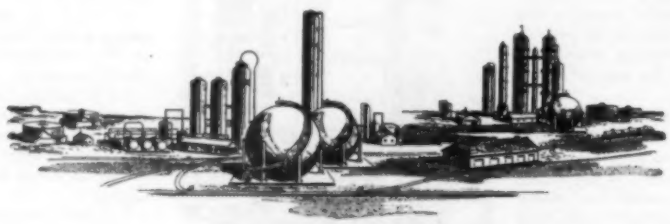
ACKNOWLEDGMENT

The reviews and constructive criticisms of this article by J. C. Elgin, J. K. Dixon, and K. W. Saunders are gratefully acknowledged.

LITERATURE CITED

[1] American Cyanamid Co., New Product Bulletin No. 14, "Dipropionitriles," 1950.
[2] Asselin, G. F., and Comings, E. W., *Ind. Eng. Chem.*, **42**, 1198 (1950).
[3] Elgin, J. C., *Ind. Eng. Chem.*, **42**, 17 (1950).
[4] Francis, A. W., *Ind. Eng. Chem.*, **36**, 764 (1944).
[5] Golumbic, C., Orchin, M., and Weller, S., *J. Am. Chem. Soc.*, **71**, 2624 (1949).
[6] Kemp, L. C., Hamilton, G. R., and Gross, H. H., *Ind. Eng. Chem.*, **40**, 220 (1948).
[7] Riethof, G., Richards, S. G., Savitt, S. A., and Othmer, D. F., *Ind. Eng. Chem., Anal. Ed.*, **18**, 453 (1946).
[8] Saunders, K. W., *Ind. Eng. Chem.*, **43**, 121 (1951).
[9] Scheibel, E. G., *Chem. Eng. Progress*, **44**, 681, 711 (1948).
[10] Steinhauser, H. H., and White, R. R., *Ind. Eng. Chem.*, **41**, 2912 (1949).

* * *



Nomograms for the Solution Of Anchor Bolt Problems

ABRAHAM I. GARTNER

Structural Engineer, Foster-Wheeler Corporation, Oil Division, New York

THIS ARTICLE presents two nomograms which greatly facilitate the design and investigation of anchor bolts for tall towers and stacks. A number of examples are given to illustrate their application. The formulas upon which they are based are derived from the common theory of flexure for materials of dissimilar modulus of elasticity. The equations necessary for the construction of the nomograms follow in conclusion.*

THE subject of anchor bolts for tall towers and stacks has in recent years received much attention from engineers concerned with this problem. In order to deal with the large moments encountered in modern practice, it was found necessary to abandon the older, crude methods, based upon the formula $T = M/Z - P/N$ (T = tension in extreme bolt; N = number of bolts in circle; Z = section modulus of bolt circle), and to seek a new approach by attempting to base the design upon the actual location of the neutral axis.

Several such methods were described recently; some in published articles[1,2] and others in privately circulated papers. In these methods the design generally proceeds from first principles involving cumbersome and time consuming calculations. This circumstance discourages the attempt of a second or third trial which, as is often the case, becomes necessary in order to arrive at a satisfactory solution.

In accordance with the straight-line theory of reinforced concrete, with a given set of working stresses in steel and concrete the neutral axis becomes fully determined. It is then possible to solve for the required areas of base ring and anchor bolts to satisfy those stresses. In the majority of cases, however, it will be found that the width of base ring computed in this manner is too small to accommodate the anchor bolts. Increasing the areas of base ring and anchor bolts in the same proportion, will preserve the assumed location of the neutral axis and at the same time will decrease the stresses in steel and concrete inversely in the same ratio. This method is followed in some analytical solutions, but it is obviously wasteful of anchor bolt steel.

If the area of the base ring only is increased, the neutral axis will be displaced toward the compression side,

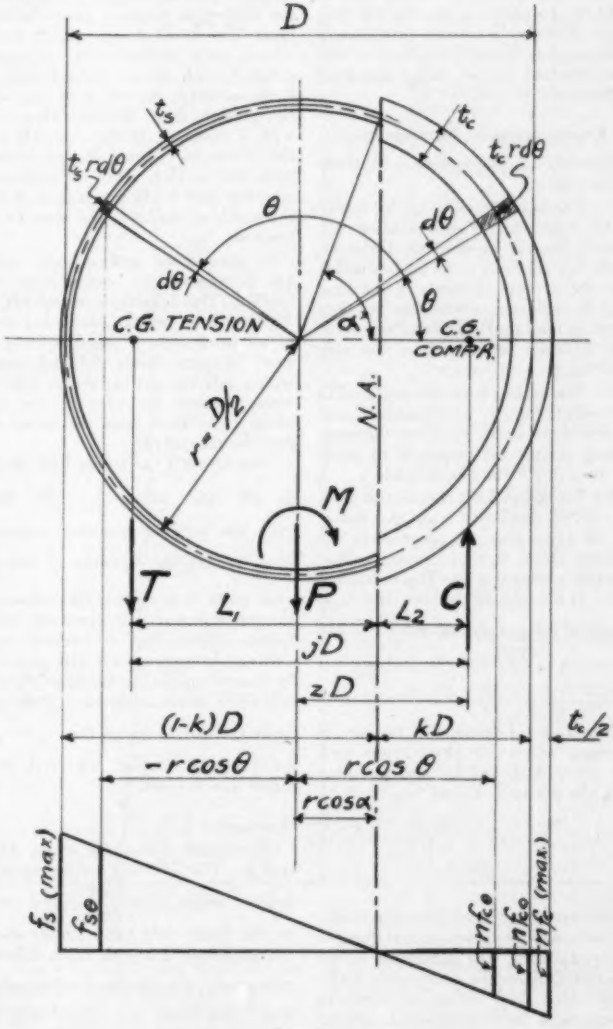


Figure 1

* NOTE: The symbols used follow customary standards and they are further explained in the diagrams and text.

and at the same time the stresses in steel as well as in concrete will be lowered. This general observation leads to the conclusion that as the base ring area is increased the anchor bolt area can be decreased. In order to find the minimum anchor bolt area that is consistent with a given base ring area and a given working stress in steel, it is necessary to resort to a procedure of trial and error. A practical size being chosen for the base ring, a set of anchor bolts is assumed, and by means of a suitable method the stresses are calculated. If the latter are not satisfactory, a second or third trial is undertaken, until the results are acceptable.

The nomograms presented herein make it possible to accomplish this result directly, without preliminary trials, and in a mere fraction of the time required by any other approved method.

Explanation of Nomograms

Simplifying assumptions were made as follows:

1) The bolt circle is in the center of the base ring. This condition can usually be met in practice. However, if the bolt circle is a few inches larger than the average diameter of the base ring, D, it should nevertheless be taken equal to the latter; the resulting error will be very small and on the safe side.

2) The anchor bolts are replaced in the calculations by an equivalent steel ring of equal area, A_c. When the number of anchor bolts is eight or more the resulting error is negligible.

3) The distance of the neutral axis, kD, being measured from the center of the base ring, f_{co} represents the bearing stress at that center farthest from the neutral axis. The maximum stress at the edge of the base ring, f_c, is larger in the proportion of $\frac{(24kD + t)}{24kD}$ (D being in feet and t in inches).

Nomogram 1

Nomogram 1 consists of two superimposed alignment charts: one with the scales A, B and k_B, and the other with the scales A, C and k_C.

$$A = \frac{100\,Pn}{A_c f_s}, \quad B = \frac{100\,Mn}{A_c f_s D} = A\frac{e}{D},$$

$$C = \frac{100\,A_s n}{A_c}$$

= percentage of steel times the modular ratio, and k = proportional distance of neutral axis. The subscripts of the k scales indicate the companion scales with which they are to be used: k_B always with the B scale and k_C always with the C scale.

In any given design problem, the area of the base ring, A_c, being first adopted, all the factors of A and B are known. A straight line connecting A and B will cut the curve k_B at the lowest and only value of k at which an anchor bolt stress of f_s can be attained with the given A_c. Having thus obtained k, place a straight edge across A and k on k_C and read C; this divided by n gives the required percentage of anchor bolt steel in terms of base ring area.

With f_s, the working stress in steel, being held at the maximum allowable, as long as k is fairly low, f_c will be quite low and it can be left to take care of itself. However, as k becomes larger, there is danger of exceeding the allowable working stress in concrete. The lines drawn across the k curves, each marked with its appropriate f_s, indicate the highest value of k above which the value of nf_{co} will be greater than 10,000. Therefore, with a given f_s, if the line AB cuts the curve k_B above its intersection with the f_s line, it is an automatic warning that f_{co} is too high and that the width of the base ring must be increased.

In accordance with current codes, nf_c is constant for concrete of any quality. The limiting value $nf_{co} = 10{,}000$ seems to take care adequately of all provisions of the code with regard to permissible bearing stress, with a safe margin for the increase of stress towards the edge of the base plate. In critical cases the actual nf_c may be computed.

Nomogram 1 can be used for design in all cases where $\frac{e}{D} \geq .50$. With very low bending moments, resulting in $\frac{e}{D} < .50$, the function of the anchor bolts is to reduce the stresses in the concrete and to increase the safety factor, rather than to prevent overturning. In such cases it will generally be found impossible to utilize the full allowable stress in the steel, making it quite feasible to design for $\frac{e}{D} = .50$, or to assume nominal steel and investigate the stresses.

Nomogram 2

Nomogram 2 has the scales A′, C and k_C. The last two are the same as before, while $A' = \frac{100P}{A_c f_{co}}$. The insert in the lower left hand corner shows the variation of k with C for different values of $\frac{e}{D}$. In problems of investigation, first enter the insert with the known value of C, proceed horizontally until the proper $\frac{e}{D}$ curve is reached, then project vertically down to read k. Next place a straight edge across the scales of the nomogram so as to intersect them at the now known values of C and k, and read A′. This can be solved for f_{co}, and f_s can in turn be determined from proportional distances to the neutral axis.

The second nomogram was constructed in order to cover the full range of k, which was impossible on the first. However, for low values of k the second step in investigation can be carried out in Nomogram 1 as well. In fact, this is the only one that can be used to find the stresses in the special case of pure bending, i.e. $\frac{e}{D} = \infty$. Since in this case P = 0, A or A′ are also equal to zero, and the stresses must be obtained from the B scale. With k determined from the insert on Nomogram 2, place a straight edge on Nomogram 1 across A = 0 and k on the k_B curve and read B; solve this for f_s and find f_c from proportional distances.

Examples in the Application of Nomograms

1) *Design—General Case.*

Given a self supporting steel stack, erection weight P = 120 k, overturning moment M = 3600 k feet, average diameter of base (= diameter of bolt circle) D = 15 feet, width of base ring t = 10 inches, modular ratio n = 10 (for concrete of 3000 psi. ultimate), and maximum working stress in steel $f_s = 16$ ksi.

$A_c = 12 \times 3.14 \times 15 \times 10 = 5650$ si.

$$A = 100\frac{Pn}{A_c f_s} = \frac{120{,}000}{5650 \times 16} = 1.325$$

$$B = 100\frac{Mn}{A_c f_s D} = \frac{3{,}600{,}000}{5650 \times 16 \times 15} = 2.65$$

On Nomogram 1 place straight edge across A = 1.325 and B = 2.65, read on k_B k = .178; place straight edge across A = 1.325 and k = .178 on k_C, read C = 6.05.

$$A_s = C\frac{A_c}{100n} = \frac{6.05 \times 5650}{100 \times 10} = 34.2 \text{ si.}$$

Use 20 — 1¾-inch diameter anchor bolts; $A_s = 34.9$ si.

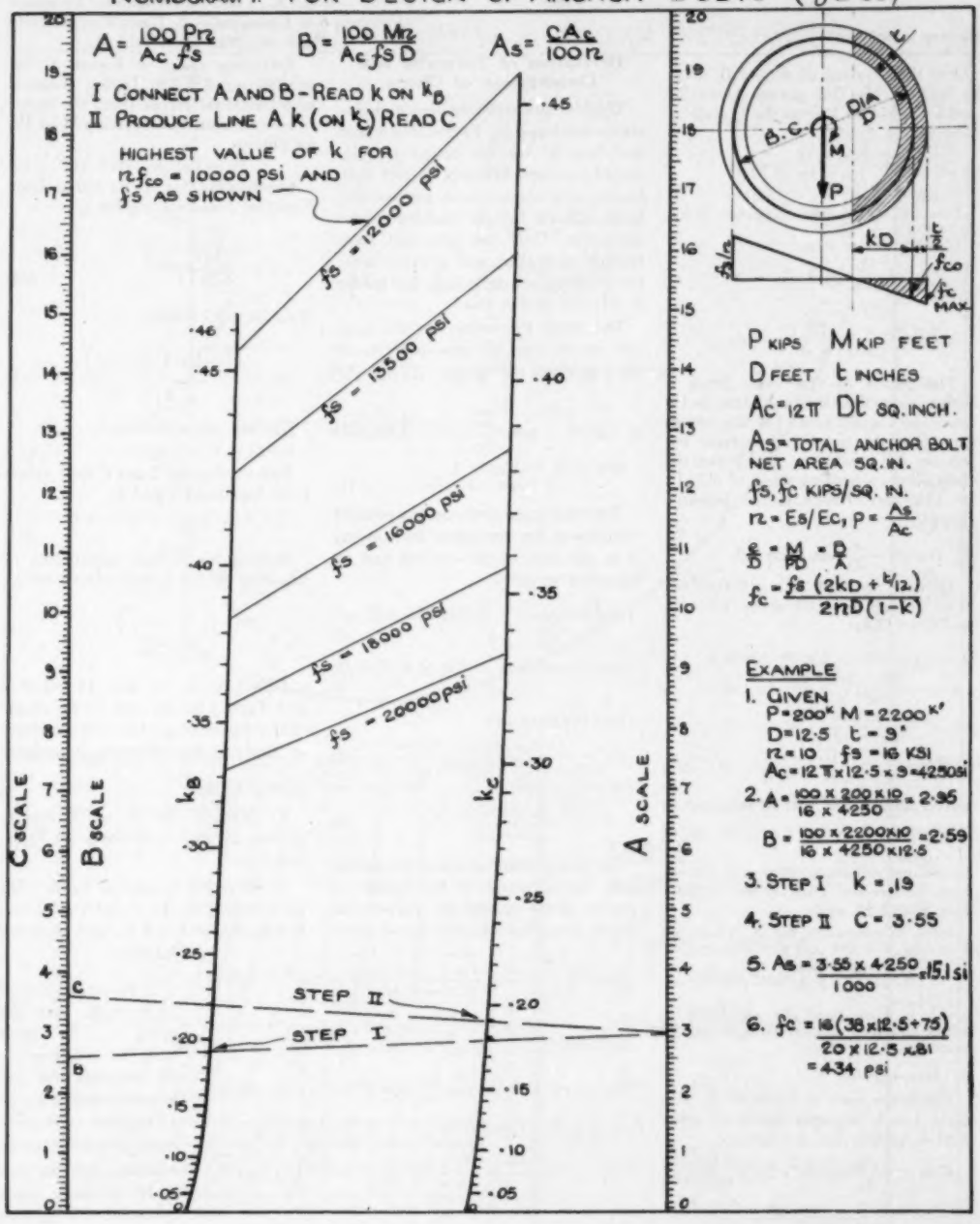
Since k is well below the line marked $f_s = 16{,}000$ psi., it is not necessary to check the concrete stress.

2) *Design—t Assumed Too Small.*

Given P = 600 k, M = 7800 k feet, D = 10.83 feet, t = 10 inches, n = 10, and $f_s = 18$ ksi.

$A_c = 12 \times 3.14 \times 10.83 \times 10 = 4090$ si.

NOMOGRAM I. FOR DESIGN OF ANCHOR BOLTS ($\frac{e}{D} \geq .50$)



P KIPS M KIP FEET
D FEET t INCHES
$A_c = 12\pi Dt$ SQ. INCH.
A_s = TOTAL ANCHOR BOLT NET AREA SQ. IN.
f_s, f_c KIPS/SQ. IN.
$r2 = E_s/E_c$, $p = \frac{A_s}{A_c}$
$\frac{e}{D} = \frac{M}{PD} = \frac{p}{A}$
$f_c = \frac{f_s(2kD + t/12)}{2nD(1-k)}$

EXAMPLE

1. GIVEN
   P = 200^K M = 2200$^{K'}$
   D = 12·5 t = 9"
   r2 = 10 f_s = 16 KSI
   $A_c = 12\pi \times 12{\cdot}5 \times 9 = 4250$ si
2. $A = \frac{100 \times 200 \times 10}{16 \times 4250} = 2{\cdot}95$
   $B = \frac{100 \times 2200 \times 10}{16 \times 4250 \times 12{\cdot}5} = 2{\cdot}59$
3. STEP I k = .19
4. STEP II C = 3·55
5. $A_s = \frac{3{\cdot}55 \times 4250}{1000} = 15.1$ si
6. $f_c = \frac{16(38 \times 12{\cdot}5 + 75)}{20 \times 12{\cdot}5 \times .81} = 434$ psi

$$A = \frac{100 \times 600 \times 10}{4090 \times 18} = 8.15$$

$$B = \frac{100 \times 7800 \times 10}{4090 \times 18 \times 10.83} = 9.80$$

Connect A = 8.15 and B = 9.80 on Nomogram 1, read on k_B k = .375. This falls above the line marked f_s = 18,000 psi., indicating that nf_{co} exceeds 10,000. Therefore a wider base plate must be used, say t = 12 inches,

Revised $A_c = 4090 \times \frac{12}{10} = 4900$ si.

Revised A $= 8.15 \times \frac{10}{12} = 6.78$

Revised B $= 9.80 \times \frac{10}{12} = 8.15$

For these values of A and B, k on k_B is .343; the line across A = 6.78 and k = .343 on k_c cuts the C scale at C = 18.

$$A_s = \frac{4900 \times 18}{100 \times 10} = 88 \text{ si.}$$

Use 24 — 2½-inch diameter bolts, $A_s = 89.1$ si.

Check concrete stress:

$$f_c = \frac{f_s\left(2kD + \frac{t}{12}\right)}{2nD(1-k)}$$

$$= 18\frac{(.686 \times 10.83 + 1)}{20 \times 10.83 \times .657} = 1065 \text{ psi.}$$

The plinth in this case, being 6 inches wider than the base plate, is 1.5 times the contact area; for this condition, plus the usual 1/3 increase for stresses due to wind or earthquake, the code allows a bearing stress of .382 f'c or 1145 psi. Hence design is satisfactory.

3) *Design—*$\frac{e}{D}$ *Less than .50.*

Given P = 300 k, M = 1800 k feet, D = 15 feet, t = 10 inches, n = 10, and f_s = 12 ksi.

$A_c = 12 \times 3.14 \times 15 \times 10 = 5650$ si.

$$A = \frac{100 \times 300 \times 10}{5650 \times 12} = 4.42$$

$$B = \frac{100 \times 1800 \times 10}{5650 \times 12 \times 15} = 1.77.$$

Here $\frac{e}{D} = \frac{B}{A} = \frac{1.77}{4.42} = .0 < .50$;

only nominal steel will be required. It is practical to design for $\frac{e}{D} = .50$, or to assume minimum steel and investigate the stresses. Thus, if M = 2250 k feet, B = 2.21, and

from Nomogram 1 for A = 4.42 and B = 2.21, k = .194 and C = .48;

$$A_s = \frac{.48 \times 5650}{100 \times 10} = 2.71 \text{ psi.,}$$

which is quite small. In practice 8 — 1-inch diameter anchor bolts would be provided, $A_s = 4.41$ si.

4) *Investigation.*

Given the case of Example 3, with eight 1-inch diameter bolts, all other data as before, find the stresses:

$$C = 100\frac{nA_s}{A_c} = 100 \times 10 \times \frac{4.41}{5650}$$

$$= .78; \frac{e}{D} = .40;$$

In the insert of Nomogram 2 starting with C = .78 go horizontally to e/D = .40 and vertically down to k = .49; on the nomogram a line across C and k as found gives A' = 31.4;

$$f_{co} = 100\frac{P}{A_c A'} = \frac{100 \times 300}{5650 \times 31.4} = 169 \text{ psi.}$$

$$f_s = \frac{nf_{co}(1-k)}{k} = 10 \times 169 \times \frac{.51}{.49}$$

$$= 1760 \text{ psi.}$$

Derivation of Formulas and Construction of Charts

The fundamental equations and constants developed by Taylor, Thompson and Smulski for the design of reinforced concrete chimneys in their well-known concrete textbook are particularly suitable for the problem under discussion. Only the principal steps leading up to them will be given here; for the detailed derivation the reader is referred to that text.[3]

The usual expression for the location of the neutral axis in terms of the maximum stresses is

$$k = \frac{1}{1 + \frac{f_s}{nf_{co}}}. \quad (1)$$

Referring to Figure 1,

$$\alpha = \cos^{-1}(1-2k) \quad (2)$$

Expressing the stress on any element in terms of the maximum, multiplying it by the area of the element and integrating we get:

Total tension $T = \frac{1}{2} K_t f_s t_c D$, and (3)

Total compression $C = \frac{1}{2} K_c f_{co} t_c D$ (4)

where the constants

$$K_t = \frac{2(\pi - \alpha)\cos\alpha + \sin\alpha}{(1 + \cos\alpha)} \quad (5)$$

and

$$K_c = \frac{2(\sin\alpha - \alpha\cos\alpha)}{1 - \cos\alpha}, \quad (6)$$

By taking moments about the neutral axis, the distances of the centers of gravity of the tension and compression forces from that axis are found to be:

$$L_1 = D\left(\frac{(\pi-\alpha)\cos^2\alpha + .5(\pi-\alpha) + 1.5\cos\alpha\sin\alpha)}{2[(\pi-\alpha)\cos\alpha + \sin\alpha]}\right),$$

and $L_2 = \frac{D(.5\alpha - 1.5\sin\alpha\cos\alpha + \alpha\cos^2\alpha)}{2(\sin\alpha - \alpha\cos\alpha)}$.

Since $L_1 + L_2 = jD$, and $\frac{D}{2}\cos\alpha + L_2 = zD$, we obtain

$$j = \tfrac{1}{2}\left(\frac{(\pi-\alpha)\cos^2\alpha + .5(\pi-\alpha) + 1.5\sin\alpha\cos\alpha}{(\pi-\alpha)\cos\alpha + \sin\alpha} + \frac{.5\alpha + 1.5\sin\alpha\cos\alpha + \alpha\cos^2\alpha}{\sin\alpha - \alpha\cos\alpha}\right) \quad (7)$$

and

$$z = -\tfrac{1}{2}\left(\cos\alpha + \frac{.5\alpha + 1.5\sin\alpha\cos\alpha + \alpha\cos^2\alpha}{\sin\alpha - \alpha\cos\alpha}\right). \quad (8)$$

Calculating α for successive values k = 0, .05, .10, etc., by means of Equation 2, the values of the constants K_t, K_c, j and z are computed by means of Equations 5, 6, 7 and 8 respectively and tabulated as in Table 1.

Referring again to Figure 1, for equilibrium $\Sigma M \equiv 0$. Taking moments of all external forces about the center of compression and replacing M by Pe, we obtain:

$$Pe - PzD - TjD = O \quad (9)$$

Substituting for T its value from Equation 3 and solving for t_s:

$$t_s = \frac{2P\left(\frac{e}{D} - z\right)}{K_t f_s j D} \quad (10)$$

But $t_s = \frac{A_s}{\pi D}$, hence

$$A_s = \frac{\left(\frac{2\pi}{j}\right) P\left(\frac{e}{D} - z\right)}{K_t f_s} \quad (11)$$

Further, for equilibrium

$$\Sigma P \equiv O, \text{ or } P + T - C = O \quad (12)$$

Substituting for T and C their values from Equations 3 and 4:

$$2P + K_t f_s t_s D - K_c f_{co} t_c D = O \quad (13)$$

Making the further substitution of Equation 10 for t_s and solving for t_c:

$$t_c = \frac{2P\left(\frac{e}{D} + j - z\right)}{K_c f_{co} j D}. \quad (14)$$

Equations 1, 11 and 14 together with Table 1 can be used for the analytical solution of anchor bolt problems by applying the following procedure:

a) *For Design:*

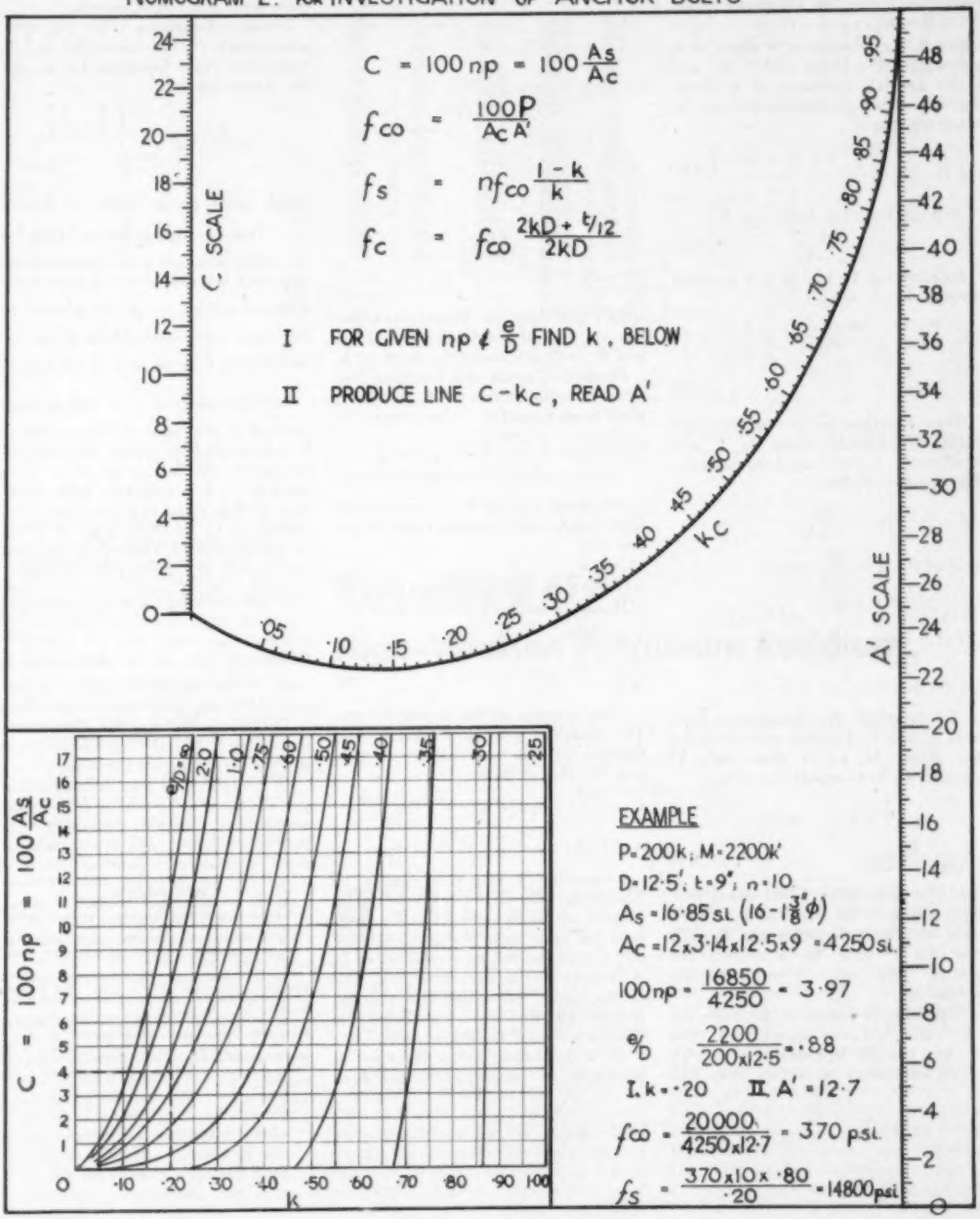
1) Given P, M, D, t_{c1}, f_s and n, assume f_{co} and calculate k by Equation 1.

2) With this k refer to Table 1 for the constants K_t, K_c, j and z, substitute in Equations 11 and 14, and solve for A_s and t_c.

3) If solved value of t_c is larger than the given t_{c1}, the latter must be increased to the required size, unless it is possible to use a higher concrete stress, in which case recompute with the new k. If, on other hand, t_c comes out smaller than t_{c1}, then assume a lower f_{co} and recompute k, A_s, and t_c. Repeat, if necessary, until t_c is close to but does not exceed t_{c1}.

b) *For Investigation:*

NOMOGRAM 2. FOR INVESTIGATION OF ANCHOR BOLTS


$C = 100np = 100\frac{A_s}{A_c}$
$f_{co} = \frac{100P}{A_c A'}$
$f_s = nf_{co}\frac{1-k}{k}$
$f_c = f_{co}\frac{2kD + t/12}{2kD}$
I FOR GIVEN np & $\frac{e}{D}$ FIND k, BELOW
II PRODUCE LINE $C - k_C$, READ A'
C SCALE
kc
A' SCALE
$C = 100np = 100\frac{A_s}{A_c}$
k
EXAMPLE
P=200k; M=2200k'
D=12·5'; t=9"; n=10
A_s = 16·85 sq. in. (16-1⅜"ϕ)
A_c = 12x3·14x12·5x9 = 4250 sq. in.
$100np = \frac{16850}{4250} = 3·97$
$\frac{e}{D}$ $\frac{2200}{200x12·5} = ·88$
I. k = ·20 II. A' = 12·7
$f_{co} = \frac{20000}{4250x12·7} = 370$ p.s.i.
$f_s = \frac{370x10x·80}{·20} = 14800$ psi

1) Given P, M, D, t_c, A_s and n, guess an arbitrary value for k.

2) Obtain constants K_t, K_c, z and j from table and solve Equations 11 and 14 for f_s and f_{co}.

3) With f_s and f_{co} thus obtained compute k from Equation 1.

4) If the computed k differs from the assumed value, try a new k lying quite near that computed in Trial 1, and recalculate f_s, f_{co} and k. Repeat, if necessary, until the computed k agrees with the assumed value.

It is shown in works on nomography that an alignment chart for three vari-

ables u, v and k can be constructed if the equation expressing them can be transformed into the following form:

$$1 = B \cdot F_1(k) + A \cdot F_2(k) \quad (15)$$

where B is a function of u alone, A is a function of v alone, and $F_1(k)$ and $F_2(k)$ are two functions of k alone. Starting with Equation 14, this can be rewritten thus:

$$t_c \pi D = A_c = \frac{\frac{2\pi}{j} P\left(\frac{e}{D} + j - z\right)}{K_c f_{co}} \quad (14a)$$

Solving Equation 1 for f_{co}:

$$f_{co} = \frac{f_s k}{n(1-k)} \quad (1a)$$

Substituting 1a in 14a and dividing through by A_c we get:

$$1 = \frac{P n e}{A_c D f_s} \cdot \frac{2\pi(1-k)}{K_c k j} + \frac{P n}{A_c f_s} \cdot \frac{2\pi(1-k)(j-z)}{K_c k j} \quad (16)$$

This equation is of the required form, the variables being Pe, P, and k, while A_c, f_s and n are held constant. The function of Pe is

$$B = \frac{Pen}{A_c f_s D} = \frac{Mn}{A_c f_s D};$$

that of P is $A = \frac{Pn}{A_c f_s}$; while

$$F_1(k) = \frac{2\pi(1-k)}{K_c k j} \quad \text{and} \quad F_2(k) = \frac{2\pi(1-k)(j-z)}{K_c k j}$$

are the two functions of k.

To construct the nomogram draw axes X and Y, choosing suitable scales for them. At x = 1 draw axis Y′ parallel to Y. Compute the values

$$x = \frac{F_2(k)}{F_1(k) + F_2(k)} \quad \text{and} \quad y = \frac{1}{F_1(k) + F_2(k)} \quad (17a, b)$$

and plot these values in the usual way. This graph is the curve of k. The Y axis ultimately becomes the B scale and the Y′ axis the A scale. (For greater detail refer to works on this subject.)

Equation 16 serves as the basis for the scales A, B and k_B on Nomogram 1. Any straight line drawn across all three cuts them at values that will satisfy that equation. Therefore, knowing any two of them—in this case A and B—will determine the third, or k.

TABLE 1

k	K_c	K_t	z	j
0.00	0.000	3.142	0.500	0.750
.05	0.600	3.008	.490	.760
.10	0.852	2.887	.480	.766
.15	1.049	2.772	.469	.771
.20	1.218	2.661	.459	.776
.25	1.370	2.551	.448	.779
.30	1.510	2.442	.438	.781
.35	1.640	2.333	.427	.783
.40	1.765	2.224	.416	.784
.45	1.884	2.113	.404	.785
.50	2.000	2.000	.393	.785
.55	2.113	1.884	.381	.785
.60	2.224	1.765	.369	.784
.65	2.333	1.640	.357	.783
.70	2.442	1.510	.344	.781
.75	2.551	1.370	.331	.779
.80	2.661	1.218	.316	.776
.85	2.772	1.049	.302	.771
.90	2.887	0.852	.286	.766
.95	3.008	0.600	.270	.760
1.00	3.142	0.000	.250	.750

Proceeding again with Equation 14a, by substituting therein for f_{co} its equivalent from Equation 1a we obtain:

$$\frac{A_c K_c f_s k}{n(1-k)} = \left(\frac{(2\pi)}{j}\right) P\left(\frac{e}{D} - z\right) + 2\pi P \quad (18)$$

Substitute for the first term on the right hand side its value from Equation 11:

$$\frac{A_c K_c f_s k}{n(1-k)} = A_c K_t f_s + 2\pi P. \quad (19)$$

Divide through by the left member:

$$1 = \frac{A_s n}{A_c} \cdot \frac{K_t(1-k)}{K_c k} + \frac{Pn}{A_c f_s} \cdot \frac{2\pi(1-k)}{K_c k} \quad (20)$$

This is again of the required form. The variables are A_s, P and k. The function of P is the same as in Equation 16; that of A_s is

$$C = \frac{nA_s}{A_c} = pn; F_1(k) = \frac{K_t(1-k)}{K_c k}$$

and $F_2(k) = \frac{2\pi(1-k)}{K_c k}$.

Computing x and y by means of Equations 17a, b the curve of k_C is plotted on the same chart as k_B, since A is the same as in the previous case and C occupies the same position as B. A straight line across scales A, k_C and C cuts them at values that satisfy Equation 20. The first two being known, the third is obtained in consequence.

If C is known, as is the case in problems of investigation, the last-mentioned three scales can be used to find A, provided k is first determined from some other relationship.

Dividing Equations 11 by 14a, after substituting in the latter for f_{co} its equivalent from Equation 1a, we get the expression

$$pn = \frac{K_c k}{K_t(1-k)} \cdot \frac{\left(\frac{e}{D} - z\right)}{\left(\frac{e}{D} + j - z\right)} \quad (21)$$

which gives pn in terms of k and $\frac{e}{D}$. This equation is not suitable for the construction of a nomogram. Consequently a series of pn—k curves for different values of $\frac{e}{D}$ are plotted in the usual way, from which k can be found when C = pn and $\frac{e}{D}$ are known.

For low values of $\frac{e}{D}$ k may be high and out of the range of Nomogram 1. It is impossible to extend the latter to encompass the full range of k, since for k = 1., A is infinitely large. However, if A is taken as a function of f_{co} instead of f_s, the full range of k can be accommodated. Making the required substitution in Equation 20 we obtain:

$$1 = np \cdot \frac{K_t(1-k)}{K_c k} + \frac{P}{A_c f_{co}} \cdot \frac{2\pi}{K_c} \quad (22)$$

Calling $\frac{P}{A_c f_{co}} = A'$ to distinguish it from A, the second nomogram is constructed in the same manner as above.

The factor 100 was introduced into the scales A, B and C merely to avoid the use of low decimal fractions.

In conclusion it may be stated that the accuracy to be attained from the nomograms compares favorably with that of ordinary engineering calculations by a slide rule.

REFERENCES

[1] E. F. Brummerstedt, Design of Anchor Bolts for Stacks and Towers, National Petroleum News, Jan. 5, 1944.

[2] S. P. Banerjee, Self Supporting Chimney Foundations, Civil Engineering (London, England), Dec., 1950.

[3] F. W. Taylor, S. E. Thompson, and E. Smulski, Concrete—Plain and Reinforced, Chap. XX, Fourth Ed., John Wiley and Sons, N. Y.

[4] E. V. Huntington, Handbook of Mathematics for Engineers, McGraw-Hill, N. Y.

[5] W. P. Linton, Nomographic Analysis of Rectangular Sections of Reinforced Concrete, Transactions of ASCE, Vol. 116, 1950, pp. 107-130.

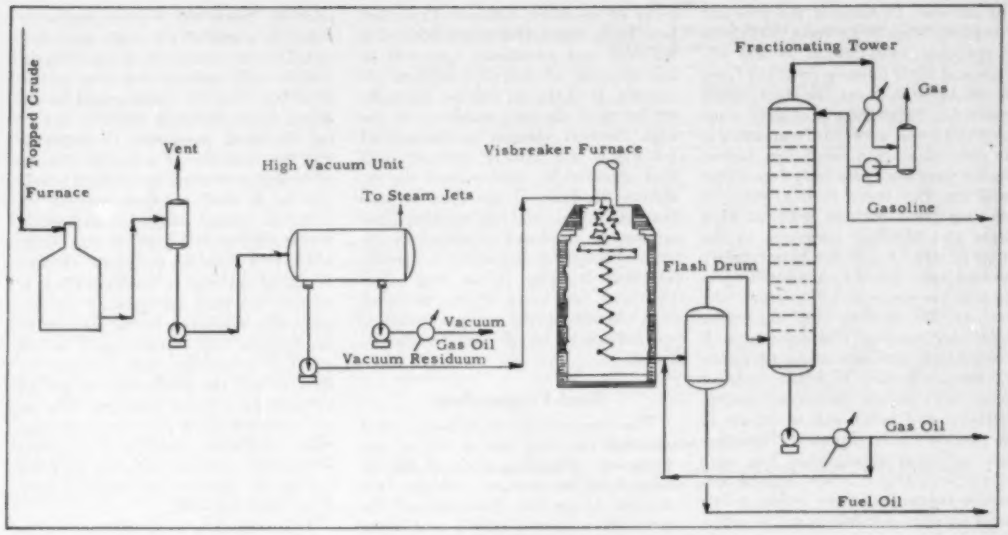


Figure 1. Commercial Visbreaking Unit.

THE INSTABILITY of the fuel oil market, the unprecedented demand for gasoline and the efficient employment of high boiling feedstocks in catalytic cracking units have given impetus to the recovery and utilization of the very heavy fractions from crude residuum. A high-vacuum distillation process now under development and operating at absolute pressures of 100 microns to 800 microns (0.1 mm to 0.8 mm) is being used to recover clean, low carbon residue, high boiling hydrocarbons from topped crude. The problem of disposing of the viscous high vacuum residuum will demand increasingly more attention as absolute pressures on high vacuum units are reduced to 100 microns and lower. Thermal cracking or visbreaking of a high vacuum has been achieved on both pilot plant and commercial equipment using a new type radiant heater and resulting in decreased fuel oil yields and increased catalytic cracking feedstocks. Results of visbreaking several different high vacuum residuums are presented.

This article was originally presented by D. M. Little before a meeting of the American Institute of Chemical Engineers at Kansas City on May 16, 1951.

Visbreaking of a High-Vacuum Petroleum Residium

J. G. ALLEN, D. M. LITTLE and P. M. WADDILL
Phillips Petroleum Company,
Bartlesville, Okla.

IN THE past few years emphasis in petroleum refining has centered on the greater utilization of the heavier fractions of crude oil. The instability of the fuel oil market, the unprecedented demand for gasoline and the efficient employment of high boiling feedstocks in catalytic cracking units all have given impetus to the recovery and utilization of the very heavy fractions of the crude. One of the simplest, most effective and economic means for the separation of heavy oil fractions is high vacuum distillation. Reference here is not to vacuum distillation in the conventional sense, but to a vacuum distillation process now under development operating at low absolute pressures in a range heretofore contemplated only in laboratories.

Just as two decades ago the refiner was pushing operating pressures higher and higher from 40 to 400 atmospheres for the conversion of light hydrocarbon gases to more valuable products by polymerization and absorption, so today we are pushing vacuum operation from 0.1 atmosphere to 0.01 and 0.001 atmosphere and the refiner can anticipate for the future practical operations of vacuum units below 0.001 atmosphere, recovering from the crude greater and greater volumes of high boiling hydrocarbons presently utilized principally for their low value Btu content. The refiner will find that the high boiling complex hydrocarbons when separated from the asphalt or tar are much more valuable as cracking stock or specialty products than their former worth as fuel oil.

We are cognizant of the problems incident to super vacuum operation. When you consider, for example, that the vapor velocity in a vacuum unit

will increase 10 times if the pressure is reduced from 50 to 5mm, 100 times in reducing from 50mm to 500 microns and 1000 times in reducing from 50 mm to 50 microns, tar entrainment becomes a paramount problem; since the criterion of successful operation is the production of a clean, low carbon residue overhead, relatively free of tar particles. For more than a year we have operated vacuum units at high loads and absolute pressures in the range of 6 to 14 mm. We have recently put into operation a vacuum unit operating in the range of 100 microns (0.1 mm) to 800 microns (0.8 mm) with significant results. The vacuum unit construction and operation necessary for the production of high yields of clean, high-quality gas-oil are unconventional and novel, and as yet are in the process of development. Nevertheless, sufficient information has been accumulated that it is now beyond conjecture to contend that within a few years vacuum distillation in the petroleum industry will operate at 100 microns or lower absolute pressure.

The application of super vacuum to recover heavy hydrocarbons from crude oil presents the refiner with the problem of disposing of the high-viscosity vacuum residuum. The refiner may wish to select the obvious solution, that is, blending the high-viscosity residuum with a low viscosity oil to fuel oil specifications and marketing as such. However, this solution may not be the best choice because not only does it degrade the fluxing oil to fuel oil level but requires selecting cut back stocks and blending techniques that will avoid settling of the fuel oil blend as a result of lack of compatibility of the stocks blended. Presented here is the successful application of a different and promising approach to the disposal of the high-vacuum residuum. It is shown that by visbreaking or mild thermal cracking of the high viscosity vacuum residuum, fuel oil yields are greatly reduced over that obtained by cutting back the residuum to fuel oil specification and that additional catalytic cracking feedstocks are produced resulting in increased gasoline and distillate yields. Thermal cracking is not novel, but thermal cracking of this denuded, high-viscosity super-vacuum residium we believe to be of considerable interest.

Feed Preparations

The proposal for installation of a catalytic cracking unit at one of our refineries initiated a study of the various feed preparation methods. Laboratory inspection characterized the crude as containing only 1 or 2 liquid volume percent asphalt. Furthermore, bench scale catalytic cracking tests indicated that the entire fraction of the crude boiling between 400° F. and 11. or possibly even 6 liquid volume percent, crude bottoms could be utilized as catalytic cracker feed if it could be produced as a clean, low carbon residue stock. However, it was also realized that vacuum reduction of the crude to 6 or 11 liquid volume percent bottoms would result in the production of a high viscosity vacuum residuum. This residuum or vacuum tar, although a relatively low percentage on the crude, when cut back to fuel oil viscosity specifications represented a considerable volume of low value product. Since the viscous residuum would be essentially a virgin stock and paraffinic in character, it was thought that by mild thermal cracking or visbreaking, fuel oil yields could be reduced and additional catalytic cracking feedstock produced. In visbreaking, the viscosity of a highly viscous residuum is reduced by thermal cracking to a total reaction product of lower molecular weight, lower boiling range, higher API gravity, and lower viscosity than the original charge. Cracking severity in visbreaking is usually less than the cracking severity generally employed in thermal cracking because the desired result is not gasoline production but viscosity reduction and the production of gas-oil suitable for further cracking. Too severe treatment not only increases gasoline production, which is of relatively low octane number, but also degrades the gas-oil fraction as potential catalytic cracking stock.

It is generally accepted that stability against heating decreases as molecular size increases. The problem then was not whether the vacuum residuum could be cracked by thermal treatment but rather a question of whether the vacuum residuum could be cracked without prohibitive coil cooking; for heavy residiums are notorious coke producers in cracking coils. To our knowledge no one in the refining industry, either past or present, had commercially visbroken a residuum so viscous, so completely stripped of gas-oil such as we were contemplating. Visbreaking of such a residuum was not only a necessity but a challenge. The challenge was met first in a pilot plant and finally on commercial scale.

TABLE 1

Pilot Plant and Bench Scale Visbreaker Charge Stocks Virgin Residuums

	Gray County, Texas Crude		Intermediate Base Crude
Volume Percent of the Crude	11.7	5.8	47.2
Percent Boiling Below 1100 °F. (Approx.)	2.0	0	12
Viscosity, SFS @ 122 °F.	1000+		
Viscosity, SFS @ 210 °F.	163	1063	110
Carbon Residue (Ramsbottom), Weight percent	10.1	16.3	17.4
Softening Point (Ring and Ball), °F.		110	123
Sulfur, Weight Percent	0.77		6.9
B. S. & W., Percent	.02	0.1	
Gravity, °API	17.8	14.7	6.9

TABLE 2

Pilot Plant Visbreaking of 11.7 Liquid Volume Percent Texas Crude Residuum

TEST NUMBER	B30-2	B30-6	B30-4	B30-5
Coil Inlet Temp., °F.	642	512	560	560
Coil Outlet Temp., °F.	974	1010	1013	1032
Inlet Pressure, psig.	170	175	170	173
Outlet Pressure, psig.	165	165	165	163
Cold Oil Velocity, feet per second	1.20	1.67	1.37	1.67
Dry Gas, weight percent of charge	1.9	1.8	2.4	2.5
Total C_4, vol. percent of charge	1.5	1.8	1.9	2.2
C_5-400, vol. percent of charge	11.4	8.9	12.0	12.9
400-650 Gasoil, vol. percent of charge	12.1	13.7	16.2	15.9
650-950 Gasoil, vol. percent of charge	17.8	19.3	18.8	19.9
950 °F. and heavier, vol. percent of charge	59.4	58.0	52.2	51.3

Pilot Plant Visbreaking

Pilot plant operations were successful in visbreaking vacuum tar. Successful visbreaking is primarily dependent upon: 1) radiant type heating with high uniform transfer rates, and 2) high oil velocities through the coil. Higher conversion and less coil coking were possible at cold oil velocities of 2 feet per second than at 0.3 feet per second. The most severe cracking attained without excessive coke formation converted 48.8 liquid volume percent of the charge to material boiling below 950° F. The temperature of 950° F. was chosen as a base point for conversion because 950° F. closely approximated the initial boiling point of the visbreaker charge. The character of the product on three of the visbreaking tests was such that the 950° F. temperature could not be determined, and for these tests the base point is 900° F.

Pilot plant and bench scale vis-

breaking tests on four different charge stocks are reported in detail. Two of the charge stocks were from a paraffinic base, Gray County, Texas crude, vacuum reduced on pilot plant equipment to residuum representing 11.7 and 5.8 liquid volume percent of the crude, respectively. The 11.7 liquid volume percent crude residuum was prepared at 3.5 mm absolute pressure at a flash temperature of 765° F. and the 5.8 liquid volume percent crude residuum at 70 microns (0.07 mm) at a flash temperature of 780° F. The third residuum for visbreaking tests was of an entirely different character. This stock was prepared from an intermediate base type crude, which was highly asphaltic in contrast to the Texas crude with an estimated asphalt content of less than 2 percent. The characteristics of the three charge stocks are shown in Table 1. Inspection of the data will show that these residuums do not have characteristics to recommend them as cracking stocks. All of the stocks have initial boiling points of approximately 1000° F. or higher, viscosities are high at 100 to 1000 Saybolt furol seconds @ 210° F., and carbon residues of 10 to 17 weight percent forewarn of coking difficulties. It is also notable that the API gravity could be misinterpreted particularly in the case of the Texas crude residuum. Although the residuum from Texas crude represented only 5.8 liquid volume percent crude bottoms and was higher boiling than the intermediate base crude residuum, its API gravity was 14.7 compared with the 6.9° API gravity of the intermediate base residuum which represented 47.2 liquid volume percent crude bottoms. This contrast serves to emphasize the paraffinic character of the Texas crude bottoms and the naphthenic character of the intermediate base crude bottoms. The fourth residuum for visbreaking tests was a vacuum reduced cracked residuum.

Operating Conditions

Briefly summarized in Table 2 are operating conditions and pertinent yields from visbreaking 11.7 liquid volume percent Texas crude bottoms. A complete analysis of yields and product characteristics is shown in Table 3. The data show that 40 to 50 liquid volume percent of the residuum charge is converted to products of lower boiling point than the charge. The major portion of the products of conversion is gas-oil (400-950° F.) and the characteristics indicate that this gas-oil is excellent catalytic cracker feedstock. Production of butane and lighter is relatively low. The debutanized gasoline yield is 9 to 13 liquid volume percent of the charge. As would be expected from mild cracking of a par-

TABLE 3

Pilot Plant Visbreaking of 11.7 Liquid Volume Percent Texas Crude Residuum
Product Distribution

	PERCENT OF CHARGE							
	Weight Percent				Volume Percent			
TEST NUMBER	B30-2	B30-6	B30-4	B30-5	B30-2	B30-6	B30-4	B30-5
Hydrogen	0.06	0.06	0.08	0.08	.....	.....	.....	.....
Methane	0.38	0.39	0.47	0.49	.....	.....	.....	.....
Ethylene	0.16	0.57	0.22	0.25	0.39	1.41	0.53	0.61
Ethane	0.42		0.49	0.50	1.05		1.23	1.26
Propylene	0.38	0.82	0.44	0.51	0.69	1.51	0.80	0.93
Propane	0.47		0.66	0.64	0.88		1.23	1.19
i-Butylene	0.43	0.50	0.17	0.17	0.67	0.78	0.27	0.27
n-Butenes			0.40	0.44			0.62	0.68
i-Butane	0.10	0.62	0.15	0.15	0.17	1.02	0.25	0.25
n-Butane	0.41		0.49	0.64	0.66		0.79	1.04
i-Pentane	0.77	0.90	0.90	1.08	1.15	1.34	1.34	1.61
Pentenes								
n-Pentane								
PF-Gasoline	8.16	6.20	8.45	9.02	10.23	7.39	10.64	11.30
400-650°F. G.O.	10.56	11.93	14.06	13.93	12.05	13.66	16.17	15.94
650-950°F. G.O.	16.48	17.81	17.52	18.44	16.48	19.32	18.82	19.93
950°F. and heavier	61.22	60.20	55.50	53.66	59.38	57.95	53.17	51.35

TABLE 3 *(Continued)*

Pilot Plant Visbreaking of 11.7 Liquid Volume Percent Texas Crude Residuum
Characteristics of Products

	BF-Gasoline				400-650 °F. Gasoil			
Test Number	B30-2	B30-6	B30-4	B30-5	B30-2	B30-6	B30-4	B30-5
ASTM Distillation, °F.								
FD Corr 760 mm	104	113	105	110	428	400	327	322
5 percent	145	158	143	147	455	444	410	410
10 percent	165	182	161	166	466	464	437	444
20 percent	193	226	186	192	480	478	467	476
30 percent	219	264	212	218	496	490	488	495
40 percent	246	287	238	243	509	507	508	512
50 percent	272	307	267	266	522	523	527	529
60 percent	296	322	293	295	535	534	548	547
70 percent	321	342	318	316	553	558	569	565
80 percent	341	359	345	339	571	577	591	585
90 percent	374	382	369	365	593	600	618	608
95 percent	394	396	389	385	607	621	638	627
End Point	400	406	403	395	636	630	658	648
Recovery, percent	97.0	97.0	97.5	97.0	98.0	98.0	98.0	98.0
Residue, percent	2.0	2.0	1.5	1.5	2.0	2.0	2.0	2.0
Gravity, °API	58.6	56.3	59.7	59.3	38.9	39.3	39.5	39.3
Reid Vapor Pressure	6.15	3.75	6.4	5.6	.....	.....	.....	.....
Bromine Number	61	52	52	58	.....	.....	.....	.....
Aniline Point, °F.	109	111	113	109	151	149	154.5	151
Refractive Index, 68°F.	1.4194	1.4245	1.4175	1.4175	1.4634	1.4630	1.4630	1.4628
Carbon Residue (Con., weight percent)	.....	.....	.....	.....	0.028	0.015	0.015	0.017
Bureau of Mines Correlation Index	.....	.....	.....	.....	25.4	25.4	24.0	24.2
Octane Number:								
Motor Clear	53.5	49.2	52.6	55.4	.....	.....	.....	.....
+1 ml TEL	58.7	53.2	56.7	58.9	.....	.....	.....	.....
+3 ml TEL	64.5	58.6	63.4	64.8	.....	.....	.....	.....
Research Clear	59.1	53.6	57.1	59.4	.....	.....	.....	.....
+1 ml TEL	.....	58.3	62.5	64.5	.....	.....	.....	.....
+3 ml TEL	.....	64.2	.....	69.8	.....	.....	.....	.....

TABLE 3 *(Continued)*

Pilot Plant Visbreaking of 11.7 Liquid Volume Percent Texas Crude Residuum
Characteristics of Products

	650-950 Gasoil				950°F. and Heavier Residuum			
Test Number	B30-2	B30-6	B30-4	B30-5	B30-2	B30-6	B30-4	B30-5
Distillation, Vacuum (Phillips)								
FD Corr. to 760 mm	575	569	635	607	.....	.....	.....	.....
5 percent	675	684	717	690	.....	.....	.....	.....
10 percent	694	701	729	703	.....	.....	.....	.....
20 percent	720	727	752	729	.....	.....	.....	.....
30 percent	740	753	773	748	.....	.....	.....	.....
40 percent	762	776	792	765	.....	.....	.....	.....
50 percent	786	798	813	783	.....	.....	.....	.....
60 percent	808	823	829	809	.....	.....	.....	.....
70 percent	833	847	853	835	.....	.....	.....	.....
80 percent	863	880	880	863	.....	.....	.....	.....
90 percent	906	927	924	902	.....	.....	.....	.....
95 percent	929	959	959	943	.....	.....	.....	.....
Recovery, percent	95.0	96.0	96.0	95.0	.....	.....	.....	.....
Residue, percent	5.0	4.0	4.0	5.0	.....	.....	.....	.....
Gravity, °API	30.0	30.4	28.9	29.9	13.1	12.5	11.6	11.1
Aniline Point, °F.	193	194	197	195	.....	.....	.....	.....
Carbon Residue (Con., weight percent)	0.013	0.017	0.017	0.016	15.10	12.40	21.20	10.10
B.S.&W., percent	.....	.....	.....	.....	0.44	0.10	0.20	0.30
Bureau of Mines Correlation Index	29.6	29.8	30.9	29.6	.....	.....	.....	.....

affinic stock, the gasoline quality is low. The F-1 octane ratings are 50 clear and 70 with 3 cc TEL.

The primary objective of visbreaking was to reduce residual fuel oil yield. Without visbreaking, the vacuum residuum would have to be cut with a low viscosity oil to viscosity specification (300 Saybolt furol seconds @ 122° F. for No. 6 fuel oil) to produce a marketable fuel oil. With visbreaking the refiner has his choice of either flashing the visbreaker product to fuel oil viscosity or vacuum flashing to a high viscosity residuum recovering gas oil, and cutting the residuum to oil specification with a refractory, degraded gasoil. The 950° F. and heavier material from visbreaking, a pitch-like material solid at room temperature, was too viscous for conventional viscosity determination. The residuum was evaluated by determining the percentage of gas-oil required in the blend to reduce the viscosity to 300 Saybolt furol seconds @ 122° F. The gas-oil used as cutting stock was catalytic cycle oil of 30° API gravity and a viscosity of 40 Saybolt universal seconds @ 100° F. The result of fuel oil evaluation both by flashing and blending is shown in Table 4. This table shows the effectiveness of visbreaking in fuel oil reduction. The visbreaker charge when cut to 300 Saybolt furol seconds @ 122° F. represented 14.8 liquid volume percent of the crude. The 300 Saybolt furol seconds yield @ 122° F. yield from visbreaking whether by direct flashing to fuel oil specification or by cutting back the 950° F. and heavier residuum is 8.5 to 10 liquid volume percent of the crude, and is a definite material reduction in residual fuel oil. The overall net fuel oil reduction due to visbreaking is in the range of 4 to 6 liquid volume percent of the crude.

TABLE 4

Fuel Oil Blends from Pilot Plant Visbreaking of 11.7 Liquid Volume Percent Texas Crude Residuum

300 Saybolt Furol Seconds Fuel Oil by Blending 950° F. and Heavier

TEST NUMBER	Charge	B30-2	B30-6	B30-4	B30-5
950 °F. and heavier, vol. percent chg.	100.0	59.4	58.0	53.2	51.3
vol. percent crude	11.8	7.0	6.8	6.2	6.0
Flux Oil to 300 SFS @ 122, vol. percent in blend	20.7	23.8	27.5	29.0	29.5
Total 300 SFS @ 122, vol. percent chg.	126	78.0	80.0	75.0	72.8
vol. percent crude	14.8	9.2	9.4	8.8	8.5

300 Saybolt Furol Seconds Fuel Oil by Fractionation of 400° F. and Heavier

TEST NUMBER	Charge	B30-2	B30-6	B30-4	B30-5
300 SFS . . 122, vol. percent chg.	.....	84.6	83.9	83.0	80.5
vol. percent crude	.....	9.9	9.8	9.7	9.4
Excess Gasoil*, vol. percent chg.	.....	4.3	7.7	4.3	6.8
vol. percent crude	.....	0.5	0.9	0.5	0.8

* Excess gasoil after flashing to 300 Saybolt furol seconds bottoms.

TABLE 5

Comparison of Pilot Plant and Bench Scale Yields for Visbreaking of Various Crude Residuums

	GRAY COUNTY, TEXAS CRUDE				INTERMEDIATE BASE CRUDE	
	LV Percent of Charge	LV Percent of Crude	LV Percent of Charge	LV Percent of Crude	LV Percent of Charge	LV Percent of Crude
Visbreaker Charge		11.7		5.8		47.2
Conversion (100-900 °F.+) LV percent	40.0	.....	40.0	.....	41.5*	.....
Yields:						
Butane and Lighter	3.6	.....	4.4	.....	2.7	.....
					wt. %	
C5-400 °F. Gasoline	11.0	.....	9.7	.....	4.5	.....
400-650 °F. Gasoil	14.0	1.6	13.2	0.8	6.7	3.2
650-900 °F., Gasoil	16.5	1.9	17.0	1.0	29.3	13.3
900 °F. and heavier	60.0	7.0	60.0	3.5	58.5	27.6
Characteristics of Products:						
C5-400 °F. Gasoline:						
°API		56.3		.....		53.0
F-1 Octane Number (Clear)		53		.....		53
400-650 °F., Gasoil:						
°API		39.3		40.0		33.0
Aniline Point, °F.		149		146		118.4
Conradson Carbon Residue, weight percent		0.03		0.0		.....
Bureau of Mines Correlation Index		25.7		22.9		39.3
650-900 °F., Gasoil:						
°API		30.0		28.8		18.5
Aniline Point, °F.		190		190		161.3
Conradson Carbon Residue, weight percent		0.013		0.13		.....
Bureau of Mines Correlation Index		28.5		32.9		61.1
900 °F. and Heavier:						
Softening Point (Ring and Ball), °F.		.....		159		216
Conradson Carbon Residue, weight percent		12.4		22.2		.....
°API		12.7		9.0		—1.5

* Water injection in coil at rate of 13 lbs. per bbl. of oil was used in this test.

Visbreaking Tests

Visbreaking tests on the 5.8 liquid volume percent Texas crude bottoms and the intermediate base crude residuum were run on laboratory bench scale equipment. Yields and laboratory tests are summarized in Table 5. The pilot plant yields from Table 2 (Test B 30-5) are also shown. Comparison of visbreaking the two residuums from Texas crude shows that for the same conversion (that is the same yield of 900° F. and heavier), the percentage yields on the charge from the 5.8 liquid volume percent crude bottoms is substantially the same as the percentage yields from 11.7 liquid volume percent crude bottoms. The small differences indicate that the 5.8 liquid volume percent crude bottoms produces a little more gas, slightly less gasoline and about the same amount of gasoil. The table shows tests at a 40 percent conversion for a direct comparison with the intermediate base crude, however, tests at 50 percent conversion show this same relative comparison of the two Texas crude residuums. It is also reported that operability on the two Texas stocks was about the same with the 5.8 liquid volume percent crude bottoms handling as easily as the 11.7 liquid volume percent crude bottoms. The intermediate base crude residuum showed considerably more coking tendency than the Texas crude bottoms and initial attempts to visbreak the intermediate base crude residuum were unsuccessful. However, the use of a coil diluent in the form of 15 pounds of water per barrel of residuum charge alleviated coil coking so that several runs at 40 liquid volume percent conversion were attained. Further attempts to increase conversion substantially above 40 percent and decrease the yield of 900° F. and heavier have resulted only in increasing gas and gasoline yields at the expense of the gas-oil yield. The laboratory tests again show the contrast in character of the Texas and intermediate base crude residuums. The relatively low API gravity and low aniline point of the gas-oil from the intermediate base crude residuum indicate the presence of ring hydrocarbons while the higher API gravity and aniline point of the gas-oil from Texas crude residuum emphasize its paraffinic characteristics

and its better ability to produce suitable catalytic cracking feedstocks.

Visbreaking a Cracked Residuum. A pilot plant run was also made to investigate visbreaking of a cracked residuum. The charge stock in this case was a vacuum reduced residuum from one pass topped crude cracking of Texas Panhandle reduced crude, and represented approximately 8.5 liquid volume percent of the crude. First attempts at visbreaking were unsuccessful due to coil coking. However, with a smaller coil and cold oil velocities of 2 feet per second, conversion of 47 liquid volume percent of the charge to 900° F. and lighter was attained. The charge, yields and product characteristics for this operation are shown in Table 6. The relatively lower boiling range, lower API gravity, lower viscosity and higher carbon residue of this charge stock when compared with the virgin Texas residuum (Table 1) indicates that this residuum has undergone some degree of cracking. In general, visbreaking of this cracked residuum required higher temperature and higher coil velocities than visbreaking the Texas virgin residuum. The table also shows that at about the same conversion level, the cracked residuum produces a higher percentage of gas, gasoline and gas oil than the virgin residuum.

TABLE 6

Pilot Plant Visbreaking of a Vacuum Reduced Cracked Residuum

Operating Conditions:	
Coil inlet temperature, °F.	540
Coil outlet Temperature, °F.	(Coked)
Inlet pressure, psig.	182
Outlet pressure, psig.	156
Cold oil velocity, ft. sec.	1.9
Charge Stock:	
Volume percent of the crude	8.3
Viscosity, SFS @ 122 °F.	1321
Viscosity, SFS @ 210 °F.	62
Carbon Residue (Conradson), weight percent	14.5
B. S. & W. percent	0.3
Pour Point, °F.	70
Gravity, °API	12.5
Vacuum Distillation (corrected to 760 mm)	
IBP	802
5 percent cond.	872
10	913
20	975
30	1015
40	1033
50	Cracked

	LV Percent of Charge	LV Percent of Crude
Yields:		
Dry Gas	2.7	....
C_4's	1.4	....
400FC$_5$-400 °F., Gasoline	11.3	....
400-650 °F., Gasoil	13.3	1.6
650-900 °F., Gasoil	27.5	2.3
900 °F. and heavier	47.3	4.0
Fuel Oil Reduction:		
Charge to Visbreaker	100.0	8.5
Cutting Stock to 300 SFS @ 122 °F. LV percent in blend*	12.7	....
Charge cut to 300 SFS @ 122 °F.	114.5	9.8
300 SFS Fuel Oil Direct from Visbreaker	82.9	7.1
Net 300 SFS Fuel Oil Reduction	....	2.7

* Cutting Stock: Catalytic cycle oil (40 Saybolt universal seconds @ 100 °F.)

TABLE 6 *(Continued)*

Pilot Plant Visbreaking of a Vacuum Reduced Cracked Residuum

PRODUCT CHARACTERISTICS	C_5-400 Gasoline	400-650 Gasoil	650-900 Gasoil	900 and Heavier Residuum
Gravity, °API	58.5	35.1	22.2	2.3
Aniline Point, °F.	107	144	178	....
Viscosity, SUS @ 100 °F.	....	....	225	....
Viscosity, SUS @ 130 °F.	....	....	112	....
Carbon Residue (Conradson), weight percent	....	....	0.8	36.6
Bureau of Mines Correlation Index	....	32.4	48.8	....
Distillation, °F.			(Vacuum)	(Vacuum)
IBP, 760 mm	114	432	585	887
5 percent	154	469	693	930
10	172	483	723	945
20	198	504	760	970
50	268	555	798	Crk'd @ 40%
70	308	589	842	....
90	375	624	898	....
EP	417	653	....	....
Residue, percent	0.5	2.5	5	....

Pilot Plant Equipment. The pilot plant used in the visbreaking tests consisted of two radiant type furnaces (one used for preheat) followed by condensing and gas separation equipment. The cracking coil was stainless steel, 497 inches in length. The coil for visbreaking virgin tar was 0.27 inch i.d. and 0.22 inch i.d. for visbreaking cracked tar. The maximum capacity of the charge pump was 17.7 gallons per hour.

The bench scale unit used in visbreaking the 5.8 liquid volume percent Texas crude residuum and the intermediate base crude residuum was a radiant fired stainless steel coil of 0.085 inch i.d. followed by flashing, condensing and gas separation equipment. The maximum cold oil velocities attainable with this equipment is about 1 foot per second.

Commercial Visbreaking

Transition from pilot plant to commercial operation is not always a simple procedure. Pilot plants usually possess flexibility and inherent characteristics which cannot be duplicated in commercial size units. For example, the high ratio of heating surface to oil volume in the small pilot plant tubes is not attainable in commercial cracking coils. This is in part overcome in commercial units by high uniform heat transfer rates and high coil velocities. However, pilot plant visbreaking indicated that certain heating conditions were desirable. These included the following: 1) maximum temperature with minimum time; 2) uniform heat transfer both around the tube and along the tube; and 3) some degree of freedom in controlling the shape of the heating curve.

In designing the heater practical factors were also desired as follows: 1) a heater with the ability to crack refractory or virgin gas oils and perform other heating services with increased efficiency over those designed in the past, in addition to its ability to crack residual stocks; 2) a heater with high thermal efficiency; and 3) a heater with improved maintenance and operation factors. These factors plus the economy of firing with a low percentage of excess air led to the selection of a specifically designed updraft radiant type heater for the commercial visbreaking unit. A heater similar in design to the visbreaking furnace had previously been suggested for refinery heaters.[1] The construction, operation and performance of this visbreaker furnace also has been discussed in another paper.[2] Briefly, the visbreaker furnace has a split flow 42-tube convection section, a six-tube shock section to shield the convection tubes and a 31-tube radiant section. All tubes are 3½ inches o.d. by ½-inch wall. The convection tubes are 7 percent chrome, the radiant tubes 9 percent chrome. The radiant tubes are in the center of the firebox and are fired by a total of 112 ceramic cup burners, 56 on each wall of the radiant box. The burners are arranged in four rows with fourteen in each row and are staggered to give uniform cover-

age of the tubes. The design capacity of the furnace is 25 million Btu. per hour to the oil.

A simplified flow sheet of the high vacuum distillation-visbreaking unit is shown in Figure 1. Reduced crude from the crude unit, representing 25 liquid volume percent of the crude, is preheated, given an atmospheric flash and charged to the high vacuum unit. The residuum from the high vacuum unit, representing approximately 13 liquid volume percent of the crude, is charged to the visbreaker furnace through a small surge tank. The furnace outlet is quenched immediately with gas-oil and charged to a flash drum. The amount flashed is controlled by the pressure on the flash drum and by either gas-oil or steam injection ahead of the flash drum. The heavy residuum make is yielded to storage off the bottom of the flash drum and the overhead vapors are charged to the bubble tower. The bubble tower makes gas and gasoline overhead and gas-oil off the bottom. The gas-oil is cooled and a portion cycled to the furnace outlet as quench oil, the remainder going to storage.

Process Considerations. Initial visbreaking operations were erratic with frequent shutdowns. A major portion of the difficulties and downtime were written off as gain in experience on a new type unit and new type operation. However, the primary reason for shutdowns was coil and transfer line coking. The last few tubes in the furnace and the transfer line near the quench oil injection would coke in a matter of two or three days requiring a shutdown for coil burnout. Coke, in fact, was found as far back in the coil as 14 tubes from the outlet. Various innovations and processing changes, such as different quench oil injection fittings and adjusting the shape of the heating curve, were tried with little or no success. Even though visbreaking was undoubtedly occurring, as evidenced by the visbreaker charge having a viscosity of 600 Saybolt furol seconds @ 122° F. and the flash drum residuum a viscosity of 200 Saybolt furol seconds @ 122° F., coke laydown limited the operation to such a short duration that it could not be accepted as commercially feasible.

Eventually, it was observed that the preheater ahead of the atmospheric flash unit prior to the high vacuum unit was cracking the vacuum unit charge to a considerable extent as evidenced by the amount of gas and gasoline flashed overhead on the atmospheric flash tower. The coil outlet temperature on the preheater was, at this time, 835° F. Since the pilot plant had shown that a cracked residuum would coke more readily than a virgin residuum, the coil outlet temperature on the atmospheric preheater was reduced to 775° F. The decrease in temperature would be expected to decrease the amount flashed in the vacuum unit resulting in the vacuum residuum to the visbreaker increasing as percent of the crude. However, in compensation, the decrease in cracking severity on the preheater produced less non-condensibles and the vacuum unit steam jets were unloaded so that the absolute pressure in the vacuum flash zone decreased 3 to 4 mm. Actually, the vacuum residuum increased only from 12 to 13 liquid volume percent of the crude. A remarkable change in visbreaking the high-vacuum residuum then occurred. Operating at the same charge rate and the same coil temperatures at which severe coking was previously experienced, the visbreaker showed no sign of coking and a run of 39 days without a shutdown was made. Other runs, equally successful, have since been made.

The charge, yields, and product

TABLE 7

Comparison of Commercial and Pilot Plant Visbreaking

OPERATING CONDITIONS	Commercial Unit		Pilot Plant	
Coil inlet temp., °F.	643		560	
Coil outlet temp., °F.	922		1032	
Inlet pressure, psig.	247		173	
Outlet pressure, psig.	95		163	
Charge rate, B/H	160		0.42	
Cold oil velocity, ft. sec.	7.3		1.67	
Charge Stock:				
LV percent crude	13.3		11.7	
°API	20.3		17.8	
Viscosity, SFS 122 °F.	500		1000+	
Viscosity, SFS 210 °F.			163	
Carbon Residue (Ramsbottom) weight percent	10.5		10.1	
Percent boiling below 1100 °F. (approx.)	20		2.0	
	LV Percent Charge	**LV Percent Crude**	**LV Percent Charge**	**LV Percent Crude**
Yields:				
Gas (C_4 and lighter)	3.6		6.2	
C_5-400	7.0		12.9	
Gasoil	12.4	1.7	6.8	0.8
Fuel Oil (300 SFS @ 122 °F.)	80.4	10.7	80.5	9.9
Total	103.4		106.4	
Fuel Oil Reduction:				
Charge to Visbreaker	100.0	13.3	100.0	11.7
Cutting Stock to 300 SFS @ 122 °F. (LV percent in blend)*		5.5		20.7
Charge cut to 300 SFS @ 122 °F.	106.0	14.1	126.3	14.7
300 SFS fuel oil direct from visbreaker	80.4	10.7	80.5	9.9
Net 300 SFS fuel oil reduction		3.4		4.8
Gasoil available as catalytic cracker feedstock	12.4	1.7	6.8	0.8

* Cutting stock: Catalytic cycle oil (40 Saybolt universal seconds @ 100 °F.).

TABLE 7 *(Continued)*

Comparison of Commercial and Pilot Plant Visbreaking
Product Characteristics

	C_5-400	Gasoil	300 SFS @ 122 °F Fuel Oil
Commercial Unit:			
°API	57.1	35.5	19.0
Aniline Point, °F.	....	180	....
Bureau of Mines Correlation Index	....	29.3	....
Carbon Residue (Conradson) weight percent	....	0.3	9.3
B.S.&W., percent	....	....	0.4
RVP	3.5	....	....
F-1 Octane Number:			
0	60.0	....	....
+3 cc TEL	70.9	....	....
ASTM Distillation (760 mm)		(Vac. Dist.)	(Vac. Dist.)
IBP	122	388	597
5 percent (Rec.)	175	460	787
10	197	475	867
20	227	498	948
50	285	580	997
90	356	750	....
EP	401	....	....
Pilot Plant:			
°API	59.3	41.5	18.2
Aniline Point, °F.	109	137	....
Bureau of Mines Correlation Index	....	24.7	....
Carbon Residue (Conradson) weight percent	....	.02	....
B.S.&W., percent	....	....	....
RVP	5.6	....	....
F-1 Octane Number:			
0	59.4	....	....
+3 cc TEL	69.8	....	....
ASTM Distillation (760 mm):			
IBP	110	375	....
5 percent Rec.	147	426	....
10	166	439	....
20	192	451	....
50	266	476	....
90	345	524	....
EP	398	567	....

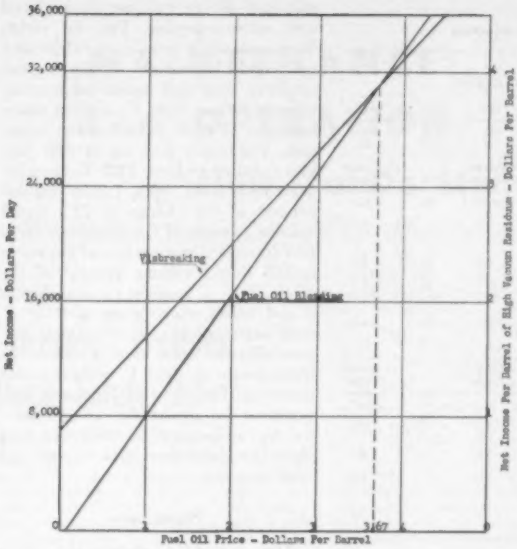


Figure 2. Economic of Visbreaking vs. Fuel Oil Blending. Basis: 60,000 barrels daily. Prices: gas, $.25 per MM Btu.; gasoline, $.11 per gallon; and No. 2 H.O.D., $.085 per gallon. Direct manufacturing expense, (per barrel): visbreaking, $.10; catalytic cracking, $.15; treating, $.03; F. O. blending, $.05 and TEL, $.0022 per cc. Cutting stock (released from fuel oil blending when visbreaking) is included in No. 2 heating oil.

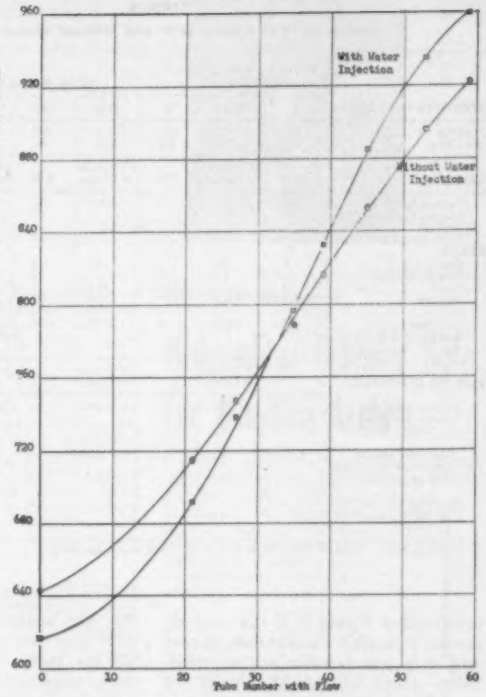


Figure 3. Visbreaker Heating Curve.

characteristics from commecial visbreaking are shown in Table 7. The highest conversion pilot plant run (Table 2, Column B 30-5) is also shown for comparison. The fuel oil and gas-oil yields have been corrected to a 300 Saybolt furol seconds @ 122° F. residuum yield direct from the visbreaking operation. It is interesting to note the difference in the charge stock characteristics of the pilot plant and the commercial unit. Although the charge stock in each case represents approximately the same percentage crude bottoms, the charge to the commercial unit has a higher API gravity, a lighter front end, and a much lower viscosity than the pilot plant charge. The difference is accounted for in the visbreaker feed preparation method. In actual refinery operations there is little doubt that cracking of the very heavy hydrocarbons occurs not only in the atmospheric flash preheater but also in the crude topping unit. The production of olefinic gases and olefinic light hydrocarbons is proof that some cracking is occurring on these units. Conversely, the pilot plant feedstock was prepared on a small scale unit with no appreciable gas production. The data in Table 7 show commercial visbreaking to be effective in reducing residual fuel oil yields. The charge to the visbreaker, blended to 300 Saybolt furol seconds @ 122° F., represented 14.1 liquid volume percent of the crude. The visbreaker product, flashed to 300 Saybolt furol seconds @ 122° F., represented 10.7 liquid volume percent of the crude or 3.4 liquid volume percent of the crude less than the fuel oil equivalent of the charge: a substantial fuel oil reduction in any refinery. Furthermore, visbreaking produced additional gas-oil of low carbon residue and high aniline point, entirely suitable as catalytic cracker feedstock. This gas-oil in a catalytic cracker, will yield about 40 liquid volume percent gasoline and 48 liquid volume percent cycle oil for No. 2 heating oil. The ultimate result of visbreaking then is decreased fuel oil, increased gasoline and increased distillate production.

Illustrative economic benefits derived from visbreaking plus catalytic cracking of visbroken gas-oil compared with straight fuel oil blending that might apply to a Mid-Continent refiner are shown in Figure 2. The commercial visbreaking data from Table 7 were used in constructing Figure 2. The net income, either in dollars per day or dollars per barrel of high-vacuum residuum for a 60,000-barrel-per-day crude charge, can be read directly from the chart. The net income is the net realization after direct manufacturing expense and before depreciation, overhead and taxes. Since no value was assigned to the high vacuum residuum which is the same in either case, the two lines illustrate the relative economics of visbreaking plus catalytic cracking as compared with fuel oil blending. At a given fuel oil price, the difference in net income between the two lines represents the incremental net income of visbreaking over fuel oil blending. According to this illustrative example, the economic advantage of visbreaking over fuel oil blending decreases with increasing fuel oil price and approaches a breakeven value as fuel oil price approaches $3.67 per barrel. However, the incremental realization in favor of visbreaking in the normal fuel oil price range of $1 to $2 per barrel demonstrates that visbreaking of high vacuum residuum is worthy of serious consideration. For purposes of simplification, catalytic cracking capacity was considered available in

TABLE 8

Commercial Visbreaking With and Without Water Injection

	WITHOUT WATER INJECTION		WITH WATER INJECTION					
OPERATING CONDITIONS	°F.	Psig.	°F.	Psig.	°F.	Psig.	°F.	Psig.
Coil Inlet	643	247	600	411	622	400	617	410
Coil Outlet	922	95	955	109	961	110	960	120
CHARGE	B/H	LV Percent of Charge	B/H	LV Percent of Charge	B/H	LV Percent of Charge	B/H	LV Percent of Charge
Vacuum Residuum	160	100.0	160	100.0	160	100.0	160	100.0
Vacuum Residuum, SFS @ 122 °F.	469		494		527		452	
Water Injection to Coil	0	.....	2	.....	2	.....	2	.....
YIELDS:								
Gas	9	5.6	9	5.6	9	5.6	10	6.2
Unstab. Gasoline	11.5	7.2	12	7.5	14	8.8	18	11.3
Gasoil	19	11.9	16	10.0	21	13.1	25	15.6
Fuel Oil	126	78.8	128	80.0	122	76.2	114	71.2
Total	165.5	103.5	165	103.1	166	103.7	167	104.3
Fuel Oil, SFS @ 122 °F.	344		366		415		343	
FUEL OIL COMPARISON:		LV Percent of Crude		LV Percent of Crude		LV Percent of Crude		LV Percent of Crude
Vacuum Residuum	.....	13.3	.....	12.5	.....	12.1	.....	11.7
Vacuum Residuum Cut to 300 SFS @ 122 °F.*	.....	14.1	.....	13.3	.....	13.0	.....	12.3
Visbreaker Fuel Oil	.....	10.5	.....	10.1	.....	9.2	.....	8.3
Visbreaker Fuel Oil, 300 SFS @ 122 °F.	.....	10.7	.....	10.3	.....	9.6	.....	8.5
Net Fuel Oil (300 SFS @ 122 °F.) Reduction	.....	3.4	.....	3.0	.....	3.4	.....	3.8

* Cutting Stock: Catalytic Cycle Oil, 40 Saybolt universals seconds @ 100 °F.

constructing Figure 2. If the catalytic cracker is loaded, the visbreaking case will show less gasoline and more distillate which will slightly lower the incremental income.

Table 7 also shows that commercial operation closely approximated the pilot plant in yields. The pilot plant produced a higher percentage of gas and gasoline because of more severe cracking but the commercial unit produced a higher percentage of gas-oil. Fuel oil yields of 300 Saybolt furol seconds @ 122° F. viscosity were approximately the same. The higher gas-oil yield from the commercial unit is probably due to the higher gas-oil content of the charge.

The heating curve of the visbreaker furnace coil which has given the best results is as nearly as possible a straight line. The last few tubes before the outlet are fired hard and have a high heat transfer rate to hold the heating curve to a straight line when the heat of cracking tends to flatten the curve. Heat transfer rates as high as 30,000 to 40,000 Btu. per square foot per hour have been calculated for the last tube in the furnace with an average heat transfer rate of 17,000 Btu. per square foot per hour in the radiant section. The average heat transfer rate in the convection section has been calculated at 6000 Btu. per square foot per hour. The design average heat transfer rates were 15,000 Btu. per square foot per hour and 4000 Btu. per square foot per hour for the radiant and convection sections, respectively. The top row of burners on both sides of the visbreaker furnace is usually shut off for visbreaking. A typical heating curve is shown in Figure 3.

Water Injection. As far as could be determined, the operation shown in Table 7 was the maximum conversion that could be obtained by adjusting coil temperatures and residence time. It was then decided to attempt to increase conversion by the old refinery standby of coil diluent. Coil diluents are commonly used in refinery operations to increase cracking severity without excessive coil coking. The diluent is usually lighter and more refractory than the fresh feed and exerts a partial pressure effect which increases vaporization, increases coil velocity and the diluent reduces the concentration of coke forming products in the coil. The diluent itself may or may not undergo cracking depending upon its characteristics and the cracking conditions. Processes such as polyforming, poly reversion and recycle cracking operate on the principle of coil diluent. The diluent used in the visbreaking operation was water.

The operating conditions and yields from visbreaking with and without water injection in the coil charge are shown in Table 8. The table shows that more severe cracking was achieved with water injection. Fuel oil yields decreased while gas-oil, gasoline and gas yields increased. At the highest cracking level coil outlet temperature increased from 922° F. without water injection to 960° F. with water injection. Visbreaker fuel oil of 300 Saybolt furol seconds @ 122° F. viscosity decreased from 80.5 liquid volume percent of the charge to 72.5 liquid volume percent of the charge or from 10.7 liquid volume percent of the crude to 8.5 liquid volume percent of the crude. It is of interest to note that at a coil outlet temperature of 955° F. with water injection, conversion is substantially the same as at a coil outlet temperature of 922° F. without water injection. The effect of increased temperature is apparently compensated for by a decrease in residence time since the visbreaker fresh charge was held constant.

Summary

The successful visbreaking of a highly viscous high-vacuum residuum representing a low percentage of crude oil bottoms has been achieved, first in a pilot plant and later on a commercial unit. The ultimate result of visbreaking is a substantial reduction in residual fuel oil and the production of high quality catalytic cracking feedstock, resulting in increased gasoline and distillate yields. Successful visbreaking is primarily dependent upon: 1) high uniform heat transfer rates, and 2) high oil velocities through the cracking coil. A radiant type heater specifically designed for flexibility in control of the heating characteristics has been adapted to commercial visbreaking. The use of 1 to 2 percent water in the coil charge as diluent allowed a substantial increase in cracking severity without an increase in coil coking.

Finally, as is desirable with most processing equipment, the visbreaker furnace possesses flexibility so that its service is not limited to visbreaking. The visbreaking unit has also been used with commendable results in cracking refractory stocks such as catalytic cycle oil. This type of heater has also been found well adapted as preheaters on vacuum units where it is expedient to arrive at operating temperatures with a minimum residence time.

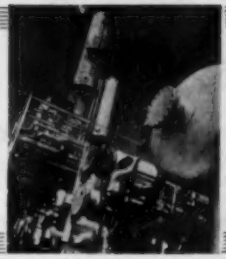
REFERENCES

[1] Mekler, L. A., and Von Fredersdorf, C. G., Petroleum Refiner, 26, 61-64, 1947.

[2] C. C. Tate, Western Petroleum Refiners Association annual meeting, April 1-3, 1951, San Antonio.

* * *

MAINTENANCE And OPERATION How To Do It—



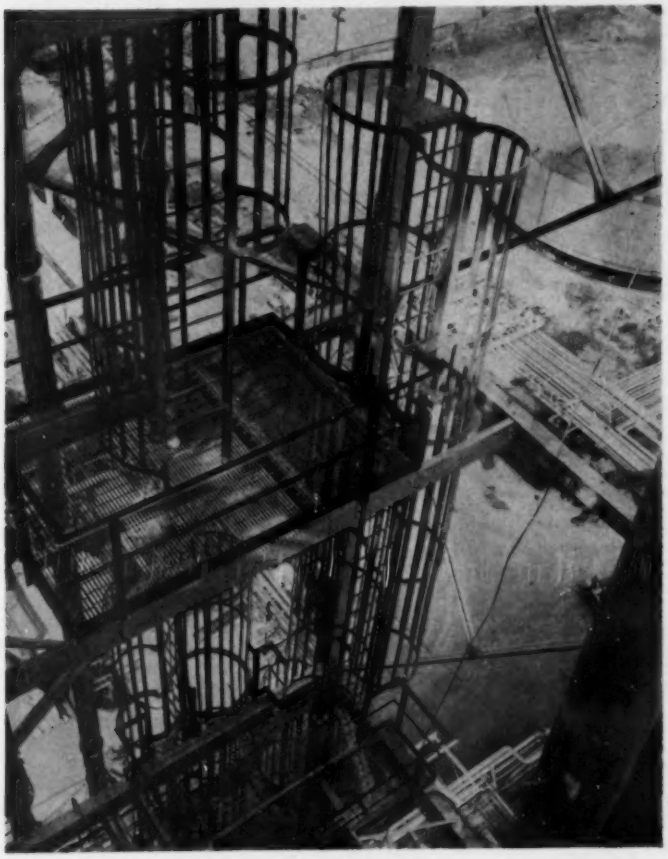
HOW—

"Firepole" Provides Quick Safety Exit

ELEVATED refinery structures are customarily provided with exit means for operators to use in the event they are trapped by fires or other emergency. These devices range from ladders and stairs and elevators to chutes and guy wires with trolleys.

On twin catalytic cracking units recently installed at the Beaumont refinery of Magnolia Petroleum Company, the tall structure is served by elevator, ladder, and stairways. The ladder installation goes a step further than usual practice, and incorporates a complete "firepole" escape route system. The individual "firepoles" are comparatively short, equal in length to the ladder runs, and utilize the same landing platforms.

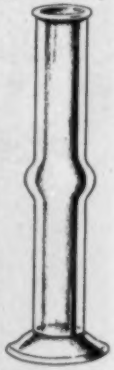
Report has it that the poles were extensively tested by construction workers who found them a quick route down at noon and evening whistle times. Perhaps they won't be needed for emergency use, but they do constitute an additional safety factor for the operating crew.



HOW TO MAKE—

Hydrometer Cylinder Safe For Handling Acids

THE CONTROL of operations in a sulfuric acid plant requires hourly Baume' gravity determinations of 93 percent, 98 percent, and 105 percent acids. In one plant an accident was experienced recently when a hydrometer cylinder slipped through an operator's gloved hand and struck a lead work table. This caused acid to splash on the operator's arm and face and resulted in minor burns.



The possibility of this type of accident happening again was minimized by having a glassblower make a circumferential bulge in the center of the straight pyrex cylinders. Also, the lower surface of the base section was roughened by sandblasting. These modifications provide a positive grip without the danger of slippage inherent in a straight-walled cylinder. They do not interfere with visibility in the upper section of the cylinder.

HOW TO—

Calibrate Temperature Bulbs

THIS is a device used in calibrating or checking any temperature measuring instrument from a dial thermometer to a temperature-controller-recorder. Fabricated from a piece of scrap 8" pipe, it has two quarter-inch needle valves manifolded together on one side and a single quarter-inch needle valve on the outlet side. The bail is made from a piece of reinforcing steel. In operation, the unit is filled with a gas oil or absorption oil.

On the dual valve manifold, one valve is connected to a steam line and the other is connected to a propane line.

By expanding propane through the

copper tubing coil, low temperatures are obtained.

By closing the propane valve and opening the steam valve high temperatures are obtained.

The temperature bulb being checked is immersed in the oil along with an accurate mercury thermometer.

Cooling or heating effects are obtained as desired by adjusting the fluid flowing through the coil and the oil bath in the container is allowed to reach the temperature or range of temperatures for which calibration checks are desired. The actual calibration is obtained, of course, by noting the reading of the accurate mercury test thermometer, any necessary corrections being made for the dial thermometer or control instrument under inspection.

HOW TO POLISH—

Floors With Air-Driven Device

WAXED concrete floors can be kept in good condition with an air-driven polisher that one man can carry anywhere the tool is needed.

The motor is a conventional air-operated unit. Air is supplied through a long hose which permits the unit to be used almost anywhere. The throttle is a small globe valve attached to the pipe handle of the machine. The polishing brush is a wood-backed unit reinforced with a circular steel plate. The speed of rotation can be controlled by the throttle valve. The over-all weight of the polisher brings out the high gloss desired by the operator.

One advantage of the device is its light weight. Another is its safety factor since no spark is possible even if the rotating head should strike a metallic surface.

HOW TO STEADY—

Pump Guide Bracket

THE support shown in the accompanying illustration prevents vertical movement in the cross-head guide for a high-pressure lean oil plunger pump.

The support is anchored in the pump block and is threaded so that the guide can be held steady without any strain being imposed. It is important to note that two bolts are provided, one above and one below the bracket fastened to the end of the guide.

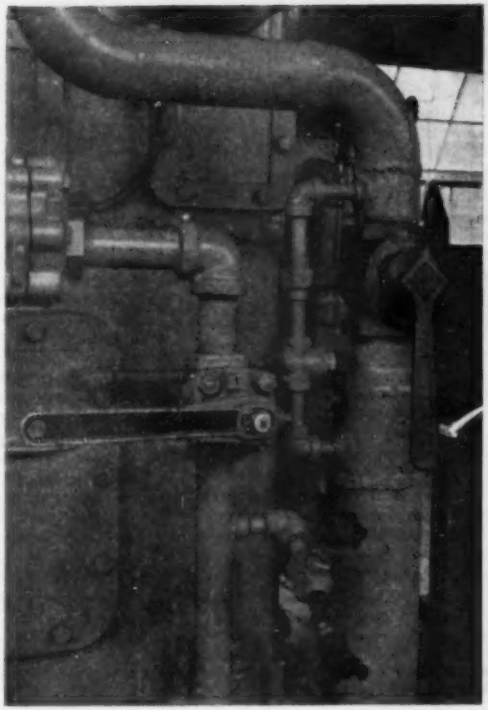
Support for the cross-head guide at the other end of the plunger is provided for by the gear box connecting the pump to the prime mover.

The advantages obtained are longer life for the packing and less over-all wear on the pump.

HOW TO REGULATE—

Fuel Gas for Compressor Engine Start-Up

THE fuel gas supply lines for compressor engines are commonly fitted with sizeable valves that easily accommodate the maximum fuel flow needed when the engines run a full operating load. During start-up operation of the engines this fuel gas flow would be excessive, and it is necessary to "crack" the fuel valve just sufficiently to allow the right small volume of gas to flow. This is a difficult adjustment with a large plug valve. One plant has been able to completely avoid the usual difficulty, the "tinkering" with the large valve, by means of small by-pass valves installed around each main fuel valve. The small valve, opened wide, supplies just the right amount of gas for start-up operation.



HOW TO

Store Ice for Small Laboratory Needs

STORING ice for occasional use in small laboratories is a minor matter that all too often wastes the time of lab men all out of proportion to its importance. One such group has found a convenient and inexpensive solution in a specially assembled insulated container.

As shown in the illustration, two steel drums, containers in which plant chemicals were originally received, were made into a double walled ice chest. The annular space between the drums was filled with loose insulating material and the top of this space sealed with a layer of asphalt. The lid, not insulated, serves to keep hot air currents away from the ice.

The ice, always conveniently available for use, melts away at a comparatively low rate.

Such a storage bin is pictured below.

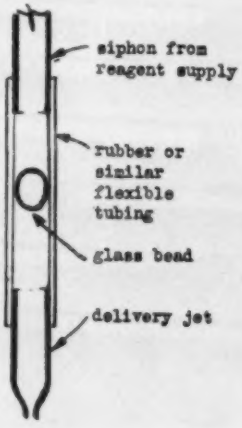
HOW TO MAKE—

Siphon Tube to Dispense Reagents

BY STORING reagents on a shelf above the test bench and taking delivery by means of a siphon tube with a suitable one-hand control device, the frequent contamination of reagents by the accidental interchange of stoppers has been eliminated, and the testing procedure simplified.

For reagents which do not attack rubber (e.g. doctor solution, caustic soda, sodium sulphide, dilute acids, etc.) the device shown in the accompanying sketch has proved most suitable. It is simply made by inserting a glass bead (which can be made by sealing one or both ends of a ¼-inch length of glass tubing of the required diameter) into a short length of rubber tubing of slightly smaller diameter than the bead. By pinching the rubber lightly at the bead the reagent flow can be controlled quite accurately with one hand, and has proved to be leak proof.

This system has given very satisfactory service, both to the plant and in the laboratory.



Ideas Are Worth Money.

Send your HOW TO DO IT suggestions with photos or sketches to Editor, Petroleum Refiner, Box 2608, Houston, Texas.

MAINTENANCE
And OPERATION
How To Do It—

METALLIZING—To Prolong Life Of Refinery Equipment

JOE E. YOUNG, JR.
General Metallizing & Machine Company, Houston

UNDER present conditions, it is sometimes difficult to obtain repair parts for refinery and gasoline plant operations. In order to save time and metal, many plant managers are turning to the metallizing process. Some refiners have used this process over a period of years, and need no urging to expand the scope of this department. Others may have tried the process once or twice without getting satisfactory results, due mainly to the use of the wrong metal, or in faulty operation of the equipment. The process is not a cure-all, but it does have several distinct advantages. If one or two points are borne in mind, there will be very little difficulty in obtaining good results.

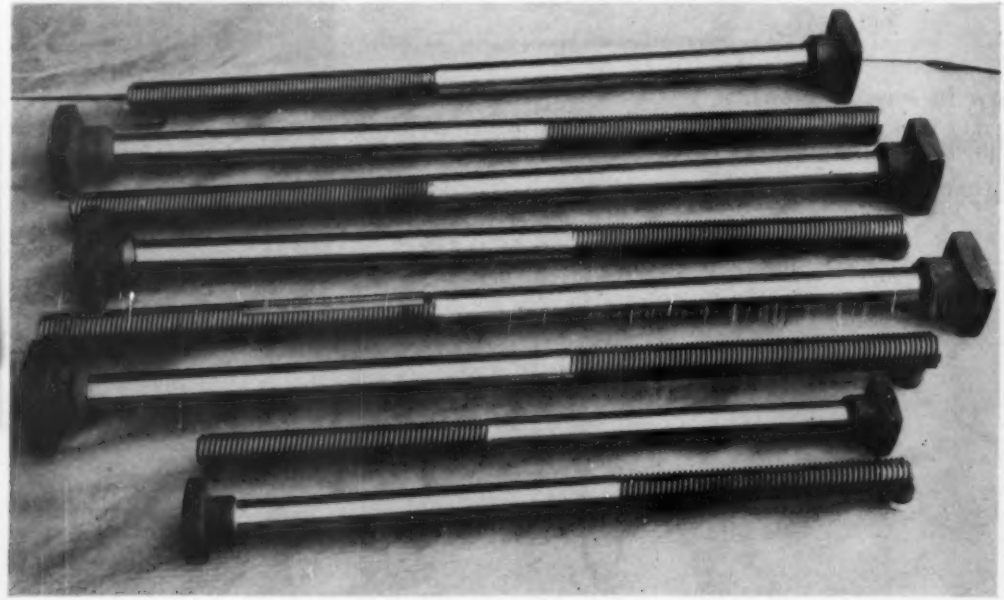
First, the deposited metal is not welded to the base metal. The bond is purely mechanical and for this reason the preparation must be thoroughly and carefully done. Second, regardless of the kind of wire used, the metal is "cast" and therefore should be machined and handled like a casting. This cast metal, incidentally, provides an excellent wearing surface, usually wearing several times longer than rolled metal of the same specification. This is because of the slight porosity of the cast metal, which absorbs and retains the lubricant. Since the base metal rarely gets hotter than about 200° F. above the atmospheric temperature, it is obvious that crankshafts, high-speed shafts, armatures, turbine shafts, and many other items may be built up by metallizing without the danger of warpage from heat. Metallizing is divided into two classes: machine elements or items that are prepared in a lathe, and flat surfaces that are prepared by sand-blasting. Both of these classes are important to the refiner, but due to certain restrictions in the use of some metals—like aluminum—the machine element class will rank first in this discussion.

METALLIZING, properly applied, offers many opportunities for savings in maintenance, time, and expense. In some cases greatly improved service can be obtained from process equipment by such methods. Process plant operators and maintenance men will do well to acquaint themselves with the present status of metallizing procedures.

The most frequent refinery applications are resurfacing pump rods and shafts; building up bearing and packing areas on steam turbines, pistons, and piston rods on gas engines and air compressors, seal rings in centrifugal pumps; filling in cavitated areas of centrifugal water pumps, and many others that will occur in normal shop operation.

Take a frequently metallized item—a worn pump rod—and follow through

Set of Automatically Operated Valve Stems Metallized with 420 Stainless Steel, and Ground to Size. Work was done at a saving of more than 50 percent over the cost of new stems.



all the steps necessary to restore it to service. First, the proper metal must be chosen for the service involved. Any metal available in wire form can be used in metallizing; monel, Inconel, lead, tin, babbitt, zinc, aluminum, bronze, stainless steel, mild steel, Hastelloy, Colmonoy, and others. If the service requires both wear and corrosion resistance, then 420 stainless steel (13/16 percent chrome steel) will be best. If wear alone is the important consideration, either a 1.20 percent carbon steel or a 1.00 percent carbon wire will be satisfactory. Where corrosion alone is the factor, either stainless steel, one of the bronzes, or special alloys will be used, depending upon the chemical conditions to be encountered.

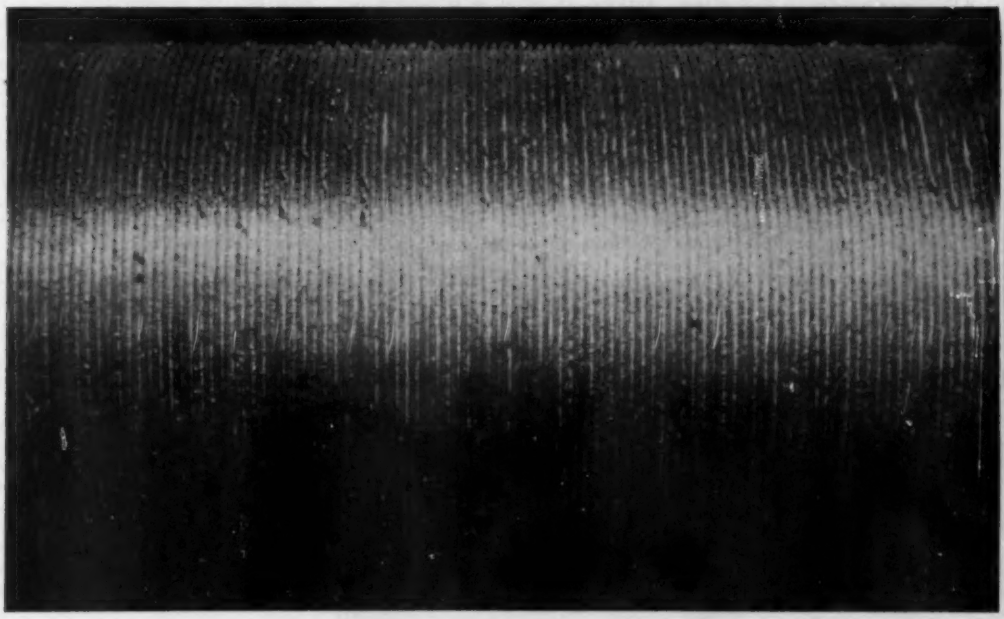
Having determined the proper wire to use, the work is next placed in the lathe, and true-up cut taken over the entire length of the worn section, overlapping the packing travel one-half inch at each end. By doing this, there will be no joint coming under the packing. The depth of the cut should be deep enough to allow for future wear without exposing the base metal. On pump rods in excess of one inch in diameter, it is customary to undercut 3/32 inch on the diameter. For smaller rods, this is reduced to 1/16 inch. See that rod is cleaned with emery cloth for a distance of about one inch beyond the undercut section. Square the shoulder at each end using a cutting-off tool. The bottom at this point should have a small radius to prevent starting a crack.

The rod is now ready to be rough-threaded. Use an ordinary threading tool that has had the side clearance ground away and the point slightly rounded. Set the point of the tool about 1/16 inch below the center of the rod, and with spindle speed reduced by the back gear, run a thread the entire length of the undercut area, 20 to 24 threads per inch. The object of this operation is to obtain a thread with a smooth bottom and well-torn sides, giving literally thousands of interstices for the sprayed metal particles to splash and lock around. Different alloys will require slightly different tool setting and speeds to obtain the best results. Some alloy shafts are either case hardened, nitrided, or so hard all the way through that ordinary machine tools cannot be used to undercut the worn area. In this case, grind the necessary metal away, mask the ends and sandblast thoroughly. If possible, use a diamond point chisel to nick the area before sandblasting. On pump rods which remain shiny after threading, it is desirable to remove the shine by sandblasting.

After completion of the threading operation, due care must be exercised that the surface does not become contaminated in any way. Onlookers have a bad habit of trying to "feel" the roughness, with their bare hands. This leaves perspiration and grease on the threads. If the spraying cannot be done at once, following the cutting of the threads, the area should be wrapped in clean paper. However, it is best to spray the rod as soon as the threading is complete, since delay may allow moisture from the atmosphere to deposit and cause trouble. The maximum time permissible between preparation and spraying depends upon the weather. When the humidity is low, as much as 24 hours may elapse without any danger of contamination. On wet days, spraying must be done within one hour after the rod is prepared.

For convenience, the metallizing gun is mounted in the lathe tool post. The various adjustments in the gas pressure are made, and the gun moved opposite one end of the prepared rod. The gun is lighted, and the final gas and air cap adjustments made, with the gun pointing away from the work

To form anchorage for the metal as it is sprayed onto the part being built up, preliminary preparation includes the formation of a rough surface. In the case of cylindrical parts, such as the pump rod shown, a thread is turned on the worn surface, with the lathe tool set slightly off center to produce a tearing action rather than a smooth turning. Into the recesses, cavities and corrugations thus formed, the molten metal is forced, and in cooling is locked firmly to the underlying materials.



so that no metal will be deposited until proper atomization is attained. Point the gun at the center of the shaft, and spray a light, thin coat, approximately .003, over the entire length to be metallized. After this tack coat, spraying is begun and continued until the area covered by the gun is built up oversize about 1/32 inch. When one spot is built up, move the carriage along enough to start a new one. Continue in this manner until the rod is built up over its entire length.

The finishing, if done in the lathe, can be started as soon as the spraying is completed, using either tool steel or carbide tools. If carbide tools are used, it is desirable to use a coolant fluid on the tool at all times. Where grinding facilities are available, it is best to grind the finish regardless of the type of steel used, because of the longer life of a ground surface over a machined one, bearing journals in particular. In preparing used cast iron, bronze or brass casting for metallizing, heat them enough to drive off any oil or grease that may have been absorbed. A temperature in the neighborhood of 300° is usually sufficient. The heating should be done with care so there will be no warping. Previously welded shafts may also have absorbed some oil.

While spraywelding is not a true metallizing process, it will be discussed before the section dealing with metallizing of flat surfaces.

With the metallizing equipment on the market today, it is possible to spray Colmonoy No. 6 metal, which will have a Rockwell hardness of 60 C. Colmonoy, as you know, is used on work subject to extreme acid conditions. This process differs slightly from the typical metallizing process.

The surface to be metallized is undercut approximately .040 on the diameter with the ends tapered out on a 45° angle. This area is then threaded, 40 threads to the inch. The surface must be sandblasted and then metallized as you would with any other metal. After metallizing, with the work still rotating in the lathe, a heating torch is used to fuse the metal to the work. Start heating the work about an inch beyond the metallized section and gradually heat into the metallized area, making sure that the Colmonoy does not get too hot and run off the work. This can usually be detected in advance by the wet appearance of the Colmonoy; this temperature will be about 1960° F. Special care must be exercised in the spraying on a 400-series stainless steel shaft, as this base metal must be allowed to come down to temperature extremely slowly to avoid cracking the Colmonoy. After cooling, the work should be ground to finish. Warpage on the order of .004 inch run out is normal.

Owing to the fusing required, spraywelding is not a true metallizing process.

Back to metallizing, and its second application: Flat surfaces, including steel vessels and structures. These surfaces are prepared for metallizing by sandblasting. Where possible, steel grit should be used. However, in warm coastal areas it is impractical to use this material because the salt air causes the steel shot to rust overnight. The small particles of rust on the shot are then transferred to the surface to be sprayed. If metal is then deposited over the rust particles, failure will be the inevitable result. In all localities where steel grit cannot be used, a flint grit should be used. The grit should be very sharp since the object is not only to clean the surface, but to produce a tearing action as well. This produces a keyed surface which grasps each little particle of sprayed metal and holds it tightly.

Since the success of the metallizing operation is so closely tied in with the sandblasting, it follows that a great deal of care must be taken to get satisfactory results every time. Be sure that the size of the blasting nozzle is not too large for the supply of compressed air available. If the blasting is started with a nozzle ¼ inch in diameter, and it wears until it is 5/16 inch, the volume of air required to keep the pressure constant is then increased from about 95 to 145 cfm at 90 pounds. If the increased volume is not available, then the pressure at the sandblasting machine drops so low that good work cannot be expected. A good air filter must be installed at the sandblast machine to remove all entrained oil and moisture from the air.

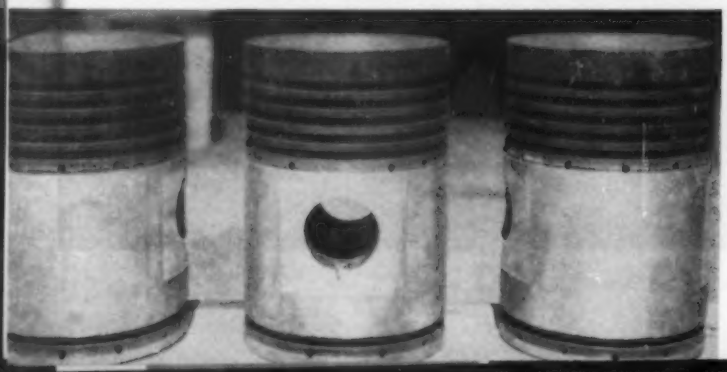
Clean only an area that can be completely metallized in the course of a shift, and a smaller area on humid days. Until the operator becomes proficient in estimating the amount of wire used per square foot, it is best to measure the surface and weigh out the wire necessary to cover this area to the correct thickness. When spraying in sections, be sure and leave a 4-inch sandblasted and unsprayed border until the adjacent section is metallized then tie the two sections together.

In spraying flat surfaces, it must be remembered that the thickness of applied metal is very definitely limited. From some inspections made recently, it appears that many operators think that if a little is good, a lot will be that much better. Nothing could be more fallacious, since if too much metal is deposited, its strength becomes such that the mechanical bond is sheared when the base metal expands or contracts. A thinner coat is not so rigid, and the bond is sufficiently strong to stretch the small amount necessary for it to follow the base metal. Each sprayed metal has a different thickness limitation. Aluminum should not exceed .010 inch, when used on exhaust stacks and mufflers, to counteract heat corrosion. Zinc should not exceed .020 inch, when used for atmospheric corrosion.

After completion of the job, remember that the coating is comparatively thin, and sharp edged or pointed tools should not be used for subsequent cleaning operations. If applying zinc, the metal as sprayed needs no further preparation if the structure is to be painted for color identification.

Metallizing equipment on the market today will operate on butane, propane, natural gas, waste refinery gases, acetylene or hydrogen. In common practice, most refineries use propane as the fuel. The use of refinery gases will produce satisfactory results if the sulfur content is low enough so none will be taken up by the metal while in the molten state.

These three nine-inch diesel pistons were metallized .030 oversize with zinc. At last report, they had been used twice as many hours as the original pistons.



"OPERATION SAFETY"

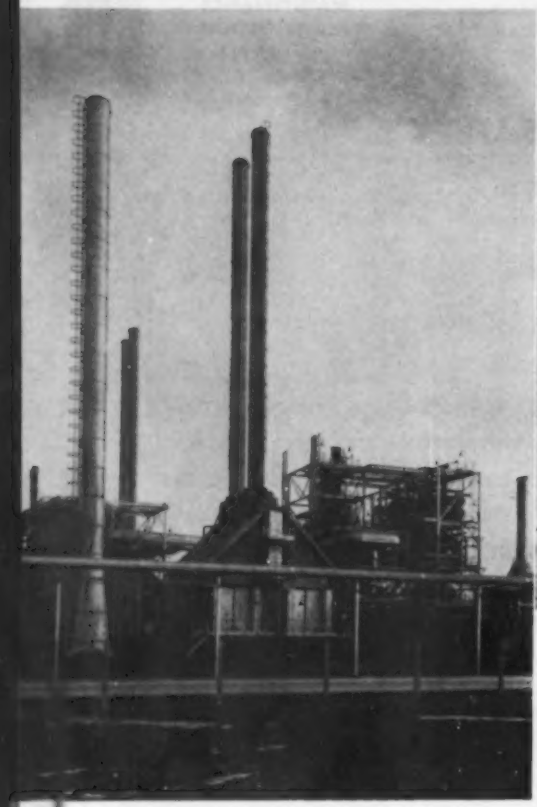
W. A. SULLENDER
Pan American Refining Corporation, Texas City, Texas

Arc Burns

The ultra-violet rays from a welder's arc cause arc-burns. The arc burn affects the sclera, or white part, of the eye; it causes painful burning which makes the eyes too painful to use. This condition may last for several hours; the severity is proportional to the length of time of exposure, and inversely proportional to the square of the distance you stand from the arc.

If you have reason for observing the actual welding operation, **use a head shield, or face shield,** which is fitted with a lens to absorb all objectionable rays, particularly ultra-violet and infra-red, emanating from the arc. Without this protection do not look at the welding arc; in fact, you should make an effort to avoid it.

Witless Willie, shown herewith at rest, was just plain curious (the accident report stated)!



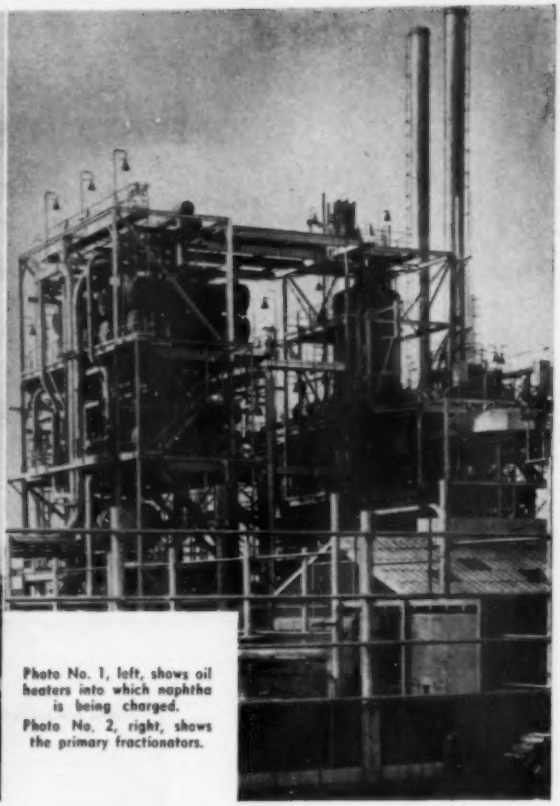
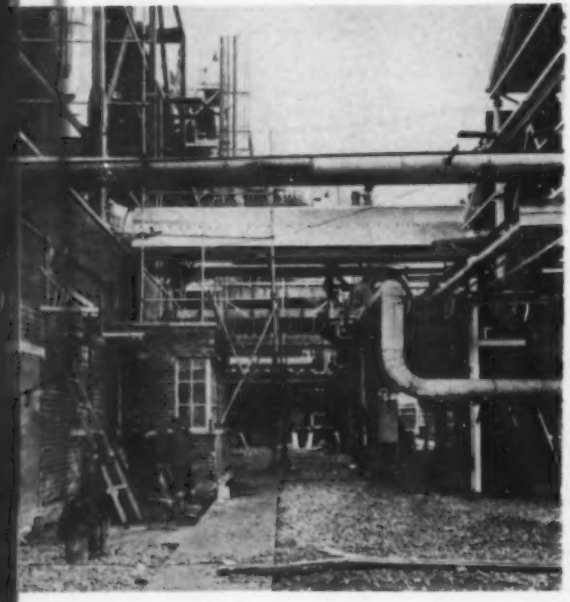


Photo No. 1, left, shows oil heaters into which naphtha is being charged.
Photo No. 2, right, shows the primary fractionators.



New Ethylene Process Uses Naphtha Pyrolysis

First Installation of Unique Manufacturing Process Under Way in England; Plant First of Its Kind in the World

Photo No. 3. Pyrolysis section where ethylene is produced.

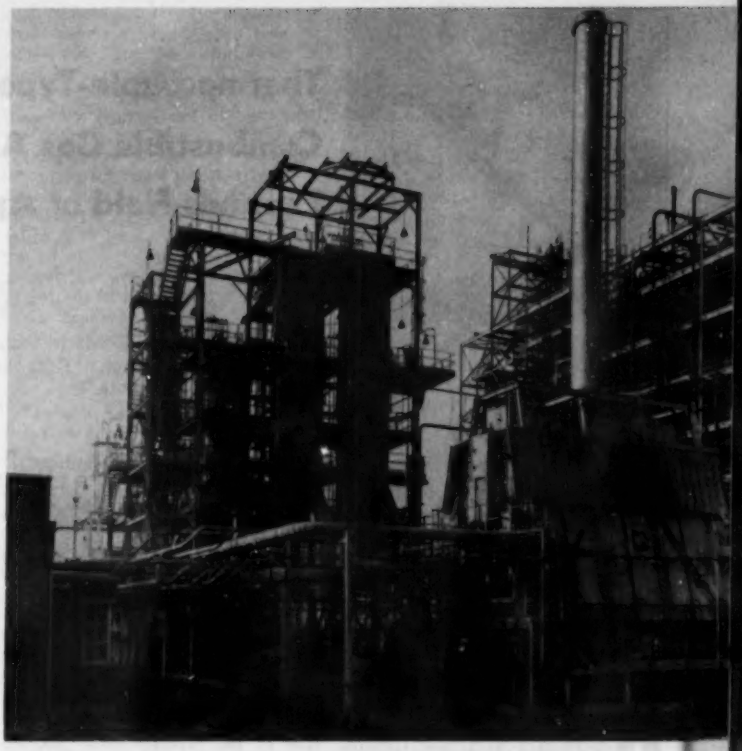


Photo No. 4. Here entrained diolefins are polymerized into polymer gasoline.

PHOTOGRAPHS on these pages feature the five principal process steps in the unique ethylene production plant now under construction by The M. W. Kellogg Company, New York, for Imperial Chemical Industries, Ltd., at Wilton, England.

This plant, first of its kind in the world, will produce as its primary product large quantities of very pure ethylene for Imperial's chemical manufacturing operation. However, it will also produce certain quantities of motor gasoline and propylene. The propylene will be further processed by Imperial into isopropyl alcohol and its derivatives.

One of the unusual problems encountered in engineering this unit, according to officials of Kellogg, is the great spread in temperature conditions required by the process. During certain stages, temperatures are above 1700°F. At others, they drop as low as —220° F.

A simplified description of the process would show naphtha being charged to the oil heaters (Photo No. 1). Before it is fractionated in the primary fractionators (Photo No. 2), it is charged to the pyrolysis section (Photo No. 3). Pyrolysis occurs in this insulated transfer line as superheated steam is introduced to raise the temperature of the oil to approximately 1700°F. It is during this step that ethylene is produced by cracking paraffinic material in the naphtha.

This mixture of hydrocarbons is then split into gasoline and lighter fractions in the primary fractionator. The gasoline fraction is debutanized and then is phosphoric acid treated to polymerize entrained diolefins into polymer gasoline (Photo No. 4).

The gases from the primary fractionator, after removal of hydrogen sulfide, pass through a special process step in which all moisture is removed to preclude icing during the later low temperature fractionation operation. After leaving the dryers, the vapors pass through catalytic acetylene-conversion step which converts virtually all of this gas into ethylene. The mixture of gases is then piped to the recovery section (Photo No. 5) where the pure ethylene is separated from the other constituents.

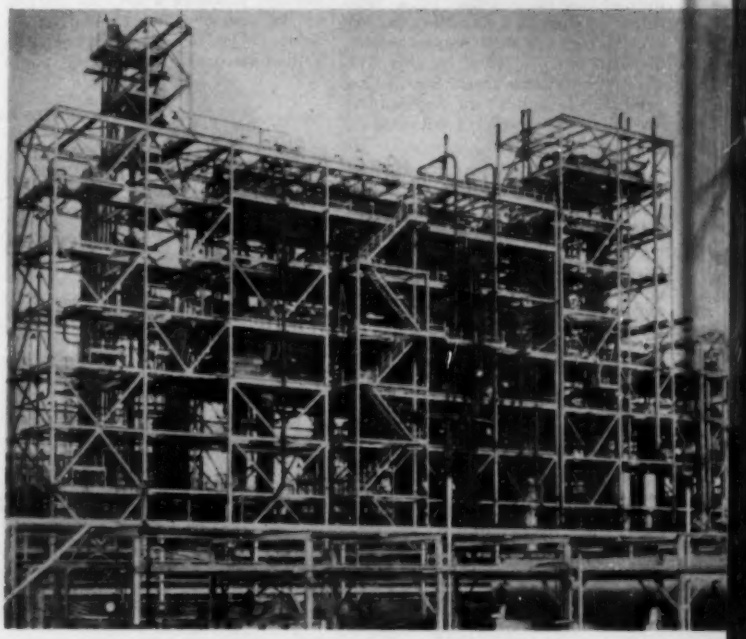


Photo No. 5. Recovery section of process where pure ethylene is separated from other constituents.

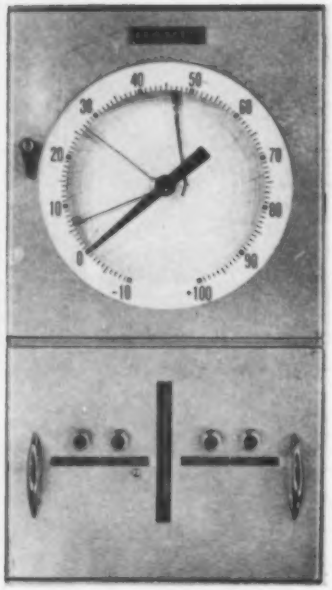


Figure 1—New Thermocouple-Type Davis Combustible Gas Analyzer for Single Point Analysis.

Thermocouple-Type Combustible Gas Analyzer Expands Field of Application

F. TAYLOR, JR.
Davis Instruments Division,
Davis Emergency Equipment Company, Newark, N. J.

THE PRESENCE of combustible mixtures can be a high hazard in process plant operating areas and in tankage or equipment opened for cleanout or maintenance. Convenient and accurate methods of measurement for combustibility are thus of real value to operating groups. This new instrument is said to incorporate these qualities.

INCREASED stability, greatly reduced zero drift, and fail-safe operation are but a few of the technological improvements effected through the development of a radically new type of combustible gas analyzer. Through these improvements, the field of application for this type of equipment has been greatly expanded, particularly in applications involving process control and unsupervised operation.

Conventional hot wire or catalytic filament-type combustible gas analyzers utilize the resistance change of a hot helical filament exposed to the combustible gas or vapor, as compared to a similar filament sealed in or exposed to air. For purposes of measurement, these filaments are generally set up in a Wheatstone bridge circuit with a fixed voltage applied. In operation, the combustible gas burns on the exposed filament and produces a change in filament resistance which unbalances the bridge in proportion to the gas or vapor present.

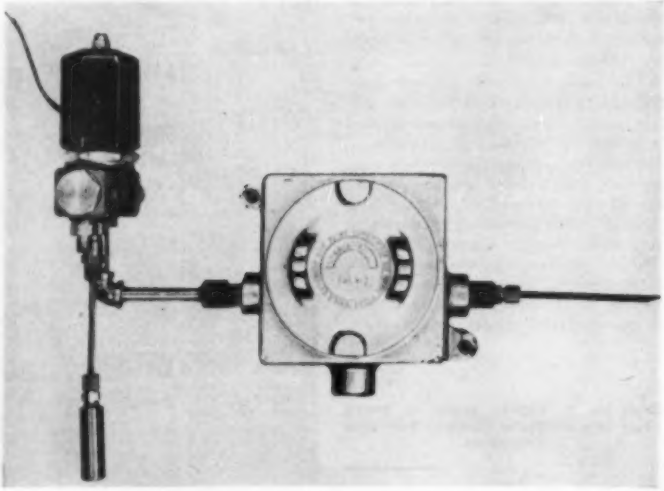
While this type of analyzer has found relatively wide usage in the past, its application is limited by inherent zero drift, which necessitates continuous supervision, especially when the filament is exposed to combustibles for long periods of time.

The cause of zero drift is evaporation of the exposed metal filament which continually alters the base resistance of the filament and, consequently, produces a constant shifting of the zero or balance point of the bridge. The new analyzer employs neither resistance measurement nor a bridge circuit, but rather utilizes thermocouples and a potentiometric circuit.

Unaffected By Evaporation

It has been found that a fine platinum wire filament with a constant voltage applied to it remains at a practically constant temperature, although the cross-sectional area of the wire grows smaller as the platinum evaporates. The explanation of this stability is dependent upon the circuit used, whereby the decrease in the cross-sectional area increases the resistance of the filament in proportion to the current drain. A new combustible gas analyzer takes advantage of this fact by directly measuring the actual filament temperature with a bonded thermocouple. As a result, the zero drift

Figure 2—Remote sampling head, showing solenoid purge valve.



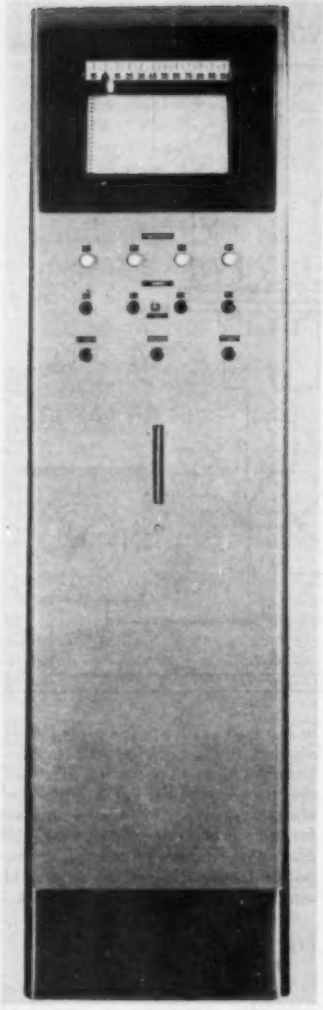


Figure 3—New Four-Point Recording Tube Sampling Unit.

and consequent lower resistance is reduced to a negligible factor.

The basic circuit arrangement of the new thermocouple-type combustible gas analyzer is shown in *Figure 4*. As illustrated, the new analyzer utilizes the temperature increase of a heated platinum filament exposed to a combustible gas or vapor air mixture, as compared to a similar heated filament and thermocouple sealed in air.

The thermocouples are connected series opposing so that a differential emf. is applied to an electronic potentiometer. With no combustible gas or vapor surrounding the exposed filament in the active cell, the emf.s from both thermocouples are equal, and since they are of opposite polarity, cancel out. Thus, the potentiometer indicates a zero potential. When a combustible gas or vapor is admitted to the analyzing chamber, it burns and the temperature of the filament increases, thereby resulting in an increased emf. from the thermocouple bonded to it. The potentiometer then indicates the resultant differential emf. which is in proportion to the concentration of combustible gas or vapors present. The potentiometer can be calibrated in terms of per cent of the lower explosive limit of the gas or vapor for which the analyzer is to be used.

Fail-Safe Feature

The new combustible gas analyzer is designed for remote-head operation, and also for tube-sampling systems.

In the single-point remote-head system, illustrated in *Figures 1 and 2*, the analyzing head is installed directly in the area being sampled, with the gas concentration transmitted electrically to the electronic recorder.

In the tube-sampling unit, illustrated in *Figure 3*, the analyzing chamber is located in the cabinet. By means of tubes, the sample is drawn from four, six or eight different areas, and commutated over the filament. The gas or vapor concentration at each point is recorded on a multiple-record, strip-chart potentiometer. The commutating valve and recorder are electrically interlocked to insure proper synchronization.

In general, these analyzers embody such advantages as: fail-safe construction, automatic reset, push-button operated purge system, extended filament life and dust-tight, plug-in relays. The relays are normally energized to insure drop out on any failure. Should flow through the analyzing head become too great or too small for correct analysis, the appliance relay will drop out and illuminate the trouble light. Filament burn-out and low-supply voltage will also produce this result.

The appliance relay is arranged so that it incorporates automatic reset. It will return to a normal operating position automatically after a high gas concentration has been corrected.

A push-button operated purging system precludes the possibility of an operator unintentionally leaving the unit in the purge position. A solenoid-operated three-way valve is installed in front of the analyzing head and provides a means of drawing fresh air

Figure 5—Davis Combustible Gas Analyzer Showing Dust-Tight Plug in Relays.

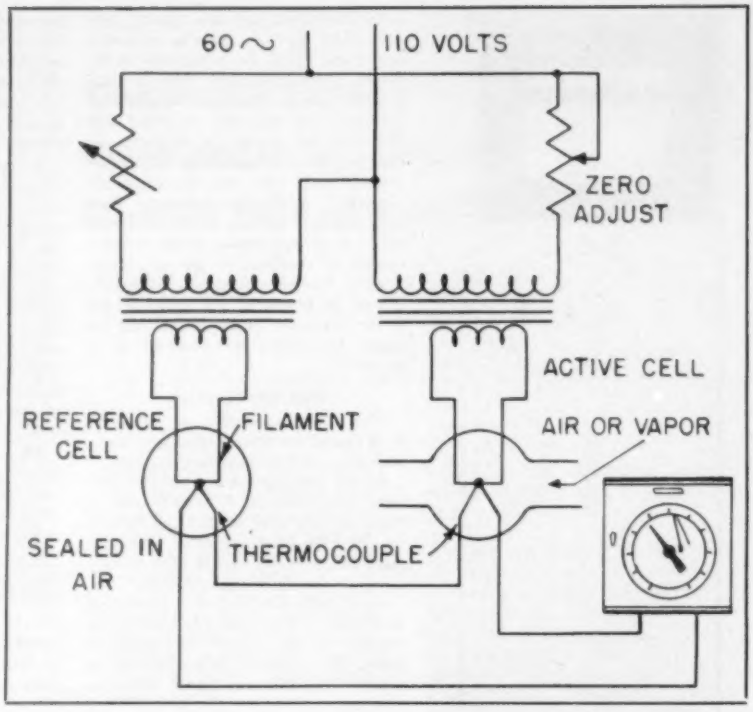


Figure 4—Basic Circuit of Davis Thermocouple-Type Combustible gas analyzer.

over the analyzing filament to permit a zero check.

All relays have been standardized so that only two different types are required for replacement purposes. This facilitates servicing and assures minimum shut-down time in the event of trouble. Tight fitting covers on all relays keep the contacts clean even under adverse conditions. Hermetically sealed relays are provided when required.

Need for Combustible Gas Analysis

Indicative of the wide variety of applications throughout industry wherein combustible gas analyzers perform an important function, are the following examples:

Coating and Vapor Recovery Systems

Where a material is coated with a substance previously dissolved in a volatile explosive solvent, the combustible gas analyzer serves an important function. Here, it detects a dangerous build-up in concentrations of the evaporated solvents in ovens caused by increased coating thickness, improper operation of the ventilating system, and excessive drive speed.

Alarm systems are used extensively on the influent and effluent side of solvent recovery systems. On the intake side of the beds they are used to keep the influent solvent-air mixture ratio below the lower explosive limit of the vapor; on the effluent side of the beds they are used to indicate breakdown or faults due to shifting of the beds.

Power Plants, Sewage Pumping Stations, Disposal Plants

The danger arising from the presence of various combustibles, such as gasoline, which may enter the sewage system, or the possible development of methane in the sewage system, often suggests the installation of a combustible gas alarm system. In like manner, the combustible gas indicator and alarm system performs an important function around the hydrogen-cooled generators in power plants, in engine-testing laboratories, oil refinery buildings, product warehouses and so on.

Pipe Line Pumping Station Application

The improved zero stability is of particular importance in supervising storage areas over week-ends and holidays when no supervisory personnel are available. This zero stability is important for use in products pipe line automatic pumping stations and small automatic process plants. In this application the high contact is connected to shut down the station before the vapor-air concentration reaches an explosive mixture.

* * *

BENZENE from Petroleum—
How and How Much

GUSTAV EGLOFF
Universal Oil Products Company, Chicago

BENZENE consumption for various products in 1950 totaled 188 million gallons and 1951 requirements are estimated at a minimum 232 million gallons. These data, together with the 1948 consumption, are shown in Table 1.

TABLE 1[1]
Consumption and Requirements of Chemical Grade Benzene
(Millions of Gallons)

PRODUCT	1948 Consumption	1950 Consumption	1951 Requirements
Styrene	47	65	82[2]
Phenol—Synthetic	39	41	50
Nylon	18	30	25[2]
Aniline	13	14	16
Synthetic Detergents (Cyclic)	7	10	12
DDT	1.5	5	6
Dichlorobenzene	5.5	5	6
Monochlorobenzene—Other than Phenol, Aniline, DDT	5	5	6
Nitrobenzene—Other than for Aniline, DDT	4	4	4
Maleic Anhydride	2	3	4
Diphenyls	2	3	3
Benzene Hexachloride	1	2	3
Miscellaneous	14	10	15
Exports	2	1	..
Total	162	188	232

Actual requirements for 1951 will undoubtedly be higher than 232 million gallons because of defense needs. About 252 million gallons has been estimated as the actual amount in demand. This quantity would necessitate an increase of 33 percent over the 1950 production of 188 million gallons. Looking five years ahead, demands are expected to be far greater. It has been estimated that if mobilization continues, 411 million gallons will be needed by 1955. The estimated annual benzene requirements for the five year period from 1951 to 1955 are given in Table 2.

TABLE 2[2]
Estimated Benzene Requirements
(Millions of Gallons)

YEAR	Total Requirements	Percent Annual Increase Over Preceding Year
1950	188	
1951	252	34.0
1952	307	21.8
1953	338	10.1
1954	379	12.1
1955	411	8.4
Increase Percent, 5-Year	....	118.6

The necessity of expansion to meet these requirements is evident from construction which is already planned or under way to increase production of benzene-derived products. Styrene capacity is being increased by about 200 million pounds a year which will require about 30 percent more benzene than is now being used for that purpose. Phenol, the second largest consumer of benzene, has a present capacity of 350 million pounds per year and is being expanded by about 43 percent or 150 million pounds. Aniline, now in short supply because of increased requirements for processing synthetic rubber, will be increased at least 20 percent in the immediate future. Broad expansion of facilities for making other products is also planned. It has been stated that although detergent capacity in 1951 will be on the order of 1.2 billion pounds, it would be increased to 2 billion pounds if sufficient benzene were available.

THE FIVE-FOLD increase in use of benzene as a chemical raw material over the ten year period from 1940 to 1950 has brought about an acute shortage. This shortage is becoming more critical with the rapidly increasing demands resulting from our mobilization program. Even under normal conditions, the growing consumption of benzene-derived civilian products would present a sizeable problem.

This discussion was presented at the annual meeting of the American Institute of Chemists, in Niagara Falls, Ontario, on May 11, 1951.

Demand for New Products

Even in the happy but doubtful event that mobilization requirements should be less than anticipated, demands for benzene will necessitate large increases in production. It must be remembered that the estimates for growth are based on the consumption of known products, many of which were not on the market ten years ago. It is safe to assume that many new products will be developed through research. Civilian requirements for benzene will probably rise markedly if the commercial development of new products is not hampered by restrictions on the construction of plants to manufacture them. Every effort should be made to reach a production of more than 400 million gallons of benzene annually by 1955.

With present capacity stretched to its limits, every potential source is being studied. These include coke-oven operation, imports, coal hydrogenation and petroleum. Present indications are that almost all of the increases will necessarily come from petroleum. Formerly, the entire benzene output was derived from coke-oven operation which is tied to steel production. The rise in demand for steel has been less than one-fourth as great as the increase in chemical grade benzene requirements. It is also true that in the expansion of steel production, provisions for increasing light oil recovery and refining equipment were omitted in some cases. Furthermore, some gas plants found that it was more profitable to leave the light oil in the gas. The recent increases in benzene prices, however, are making maximum recovery more attractive. Studies are

being made to increase light oil recovery in existing plants so that 10 million gallons more of benzene will be made available annually. It is believed that an additional 10 million gallons can be made by expanding coking capacity as now planned. These increases would raise coke-oven benzene production from the present rate of 170 million gallons to 190 million annually. This amount, however, is the maximum expected from the steel industry. To meet requirements of 307 million gallons in 1952, about 120 million gallons must be derived from other sources.

Imports have been increased and are expected to reach 40 to 50 million gallons in 1951. The shortage of benzene, however, is world-wide and it is doubtful that imports can be maintained at this level. As a matter of fact, they may be cut off entirely.

Coal hydrogenation as a source of benzene has also been the subject of much study and discussion. It has been estimated that two plants for the production of synthetic fuels would produce more than 30 million gallons of benzene yearly as one of the products. In addition to other economic drawbacks, the initial cost of the two plants is reported to be about $325 million. Moreover, construction would take from two to three years and would utilize large quantities of materials which should be allocated to industries with proven ability to produce benzene. In contrast, construction to produce this quantity of benzene from naphthenic petroleum stocks would be on the order of only $33 million and construction could be completed in about a year. It does not seem rational to attempt to meet benzene requirements by coal hydrogenation.

New Benzene Plants

Assuming maximum production from other sources, about 70 million gallons of petroleum-derived benzene will be needed in 1952 to satisfy total demands of 307 million gallons. Although present production by the petroleum industry is at the rate of only 12 million gallons per year, a number of new plants are either in the design or construction stage. Certificates of necessity have been granted for plants totalling 30.5 million gallons capacity (as of March 24). The oil industry has also applied for certificates of necessity to build additional plants which would increase benzene production by at least 30 million gallons per year. If construction is allowed to proceed, the additional capacity would raise the production from petroleum to over 72 million gallons per year. If predicted amounts are available from other sources, production should reach a rate of 312 million gallons during 1952 as shown in Table 3.

TABLE 3
Benzene Capacity, Projected for 1952

SOURCE	PRODUCTION (Millions of Gallons Per Year)
Petroleum[3]	
Present	12
Projected (Approved)	30.5
Projected (Applied for)	30
Total	72.5
Coke Ovens[2]	
Present	170
Projected Increased Capacity	10
Projected Increased Recovery	10
Total	190
Imports	50
Grand Total	312.5

Within the next five years, however, at least 100 million gallons additional capacity will be needed, and, in case imports fall off, about 50 million gallons more. The increased interest of the petroleum industry in producing benzene indicates that these requirements will be met.

At present benzene is being derived from petroleum by adaptations of the Hydroforming process which was used during World War II for producing nitration grade toluene. In the interim since World War II, a number of Hydroformers have been used for upgrading low octane gasoline into high, and more of these units could be converted to benzene production. Another process, in which two stages of processing are used, is being operated by Shell. In the first stage, methylcyclopentane derived from natural or straight-run gasoline fractions is catalytically isomerized to cyclohexane. The isomerization product plus additional cyclohexane present in the gasoline fractions are then subjected to dehydrogenation over a second catalyst.

Recently new catalytic reforming processes and new catalysts have been developed. They will be utilized increasingly in the new plants being constructed. One of these processes, called Platforming, is already in commercial operation for upgrading gasolines, and other units are now in the planning, design or construction stage for the production of benzene. Plant operation specifically carried out for the production of aromatics has shown that the process is particularly well suited for that purpose.

The most suitable stock for benzene production in Platforming operations is the fraction containing mainly C_6 hydrocarbons from a highly naphthenic gasoline. This fraction contains large percentages of methylcyclopentane and cyclohexane which are converted in one stage to benzene in contrast to some other processes which require two stages. The yield of benzene from C_6 naphthenes in a single pass is 80 percent of the theoretical and may be increased by recycling.

The U.O.P. Platforming process utilizes a catalyst containing platinum. It is a continuous process inasmuch as periodic regeneration of the catalyst is not necessary. The principal reactions which occur are dehydrogenation, hydrocracking, isomerization, and desulfurization. The small percentages of benzene already present in charging stocks go through the process without change. Aromatics result from the dehydrogenation and isomerization-dehydrogenation of naphthenes. Only minor quantities of aromatics are produced through dehydrocyclization of paraffin hydrocarbons. The hydrocracking reaction is essentially a simultaneous cracking-isomerization-hydrogenation reaction of paraffins. For example, n-decane produces n-petane and isopentane, butanes and hexanes, and propane and heptanes. This reaction also takes place to some extent with naphthenes but can be practically eliminated by controlling conditions. Low pressures favor dehydrogenation to aromatics while high pressures increase the hydrocracking reaction. The flexibility which these reactions permit makes it possible to carry out highly selective operations for the production of aromatics.

The gasoline fractions used in Platforming always contain paraffins in addition to the naphthenes, the relative percentages varying with the specific crude oil source. Consequently, gasoline is produced along with aromatics. Under the conditions used for aromatic production, the paraffins undergo isomerization to more highly branched compounds with the result that gasoline of improved octane number is obtained along with the aromatics. This point is of high importance in the over-all economics of aromatic production.

1951 Potential

The quantities of benzene potentially available from petroleum are tremendous. In estimating these amounts, production of 2.3 billion barrels (42 gallons per barrel) of crude oil for 1951 in the United States is used. Data obtained from Platforming operations indicate that the potential quantity of benzene available from the 1951 crude oil production is 825 million gallons.

A discussion of the production of benzene from petroleum would not be complete without some mention of toluene and the C_8 aromatics. These compounds are produced by the same processes as benzene and in much larger quantities. Their importance in our economic picture is also great. Toluene, as a basic material for TNT and as an aviation gasoline component, is of particular significance in our mobilization program, and, in case of war, will be needed in far greater quantities. The C_8 aromatics, which include *o*-, *m*-, and *p*-xylene and ethylbenzene, are becoming increasingly important chemical intermediates. Phthalic anhydride, which was once produced entirely from naphthalene, has also been derived from *o*-xylene for several years. An increase in capacity of petroleum-derived phthalic anhydride is highly desirable because of the naphthalene shortage. The *m*-xylene is of importane as an aviation gasoline component and experimental studies show that it will have high value as a chemical intermediate. The new synthetic fiber, Dacron, is derived from terephthalic acid which is an oxidation product of *p*-xylene. Projected facilities for the manufacture of the new fiber necessitate a great increase in production of *p*-xylene. Ethylbenzene is the basic material for styrene which accounts for the largest consumption of benzene of any single product. By increasing ethylbenzene production directly from petroleum, the benzene shortage can be somewhat alleviated.

TABLE 4
Potential Aromatics from Platforming, Estimated Yields Based on 1951 Crude Oil Production

	Million Gallons
Benzene	825
Toluene	1,650
o-xylene	500
m-xylene	1,100
p-xylene	500
Ethylbenzene	375

TABLE 5
Aromatics from U. S. Natural Gasolines, Estimated Yields from Platforming, 1951

	Million Gallons
Benzene	120
Toluene	230
C_8 Aromatics	85

TABLE 6
Summary, Aromatics from Platforming, 1951 Basis

	Total Yields, Million Gallons		
	Benzene	Toluene	C_8 Aromatics
Platforming Straight-run Gasoline	825	1,650	2,475
Platforming Natural Gasoline	120	230	85
Total	945	1,880	2,560

TABLE 7
Summary, Aromatics from Platforming, 1955 Basis

	Total Yields, Million Gallons		
	Benzene	Toluene	C_8 Aromatics
Platforming Straight-run Gasoline	1,100	2,200	3,300
Platforming Natural Gasoline	165	315	115
Total	1,265	2,515	3,415

The quantities of toluene and C_8 aromatics available from U. S. crude oil by platforming are roughly two and three times, respectively, that of benzene. A summary of the quantities of C_6, C_7, and C_8 aromatics potentially available from estimated crude oil production in 1951 is given in Table 4.

Platforming of the C_6, C_7, and C_8 fractions of natural gasolines (from natural gas) also yields aromatic hydrocarbons. On a basis of normal conversion, the potential yields of aromatics from U. S. natural gasolines on a basis of an estimated 1951 production of 110 million barrels are given in Table 5.

Table 6 gives a summary of the yields of benzene, toluene and C_8 aromatics which could be expected from use of Platforming both straight-run and natural gasolines.

Assuming for 1955 a total production of 3.1 billion barrels of crude oil and 150 million barrels of natural gasoline, an increase of about 50 percent over 1950 in each case, the potential quantities of aromatic hydrocarbons available are summarized in Table 7.

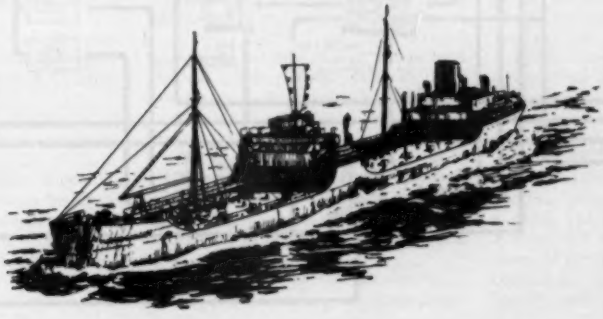
Expansion of benzene production in the immediate future will come mainly from the processing of natural and straight-run gasolines. Although the production of the required amounts of aromatics will require substantial plant construction, the petroleum industry has the ability to go ahead. It has the technical know-how and the experience to carry out all necessary expansion at a rapid rate. If given proper encouragement and cooperation, the oil industry will produce any aromatic hydrocarbon demands in the foreseeable future.

REFERENCES

[1] Data presented by L. A. Schlueter, chief, Aromatic Chemicals Section, Chemical Division, National Production Authority, before the Chemical Market Research Association, December 6, 1950.

[2] Data presented by L. A. Schlueter before the Synthetic Chemicals Association on March 15, 1951.

[3] Chem. Ind. Week 68, No. 13, 13 (1951).



Montreal East Refinery Includes UNIQUE CAT CRACKER

Two-Year Expansion and Conversion Program Is Completed by Shell Oil Co.

AFTER two years construction and conversion Shell Oil Company of Canada officially opened its Montreal East refinery last month.

Capacity is 25,000 barrels of crude oil daily or five times that of the initial installations made there in 1932. Included in the expansion, which started in 1948, are the latest type catalytic cracking unit, with new flashing and polymerization units for high-octane gasoline production, new laboratories, maintenance shops, additions to blending and distribution facilities, 750,000 gallons of tank storage, and a new office building.

The refinery occupies a 320-acre site with operational units within a compact central area about 600 feet wide by 1800 feet deep. Here are the steam generating plant, topping plants, thermal cracking units, the polymerization and solutizer plants, gas recovery and other associated installations.

Wherever possible units were built indoors and piping protected by steam insulation against severe Montreal winters.

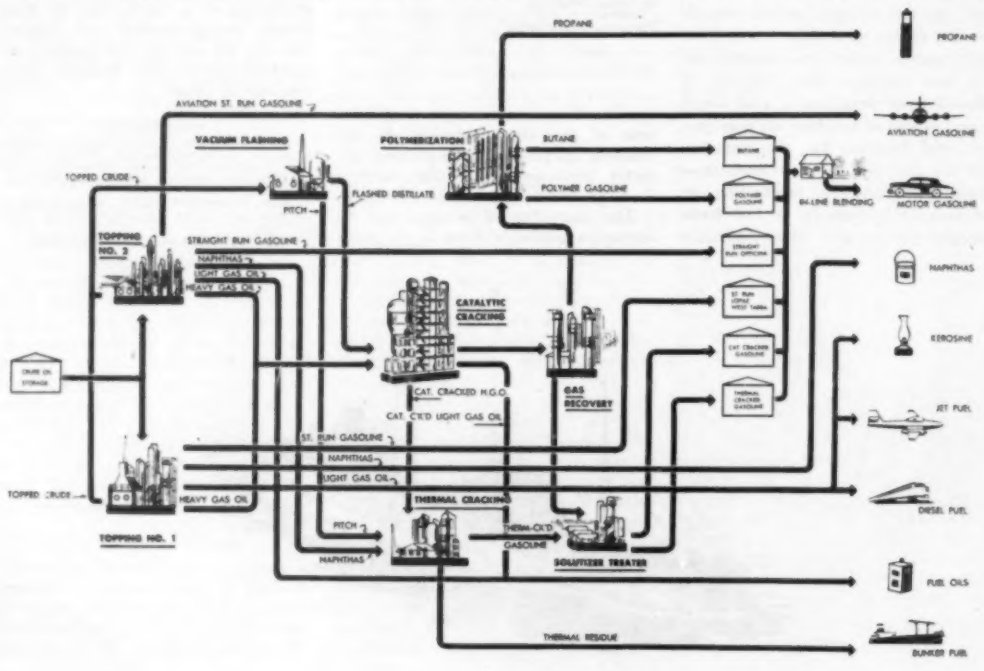
The 25,000-barrel-daily capacity is the combined intake capacity of the two topping units where crude oil is initially broken down and passed on for refining in other units.

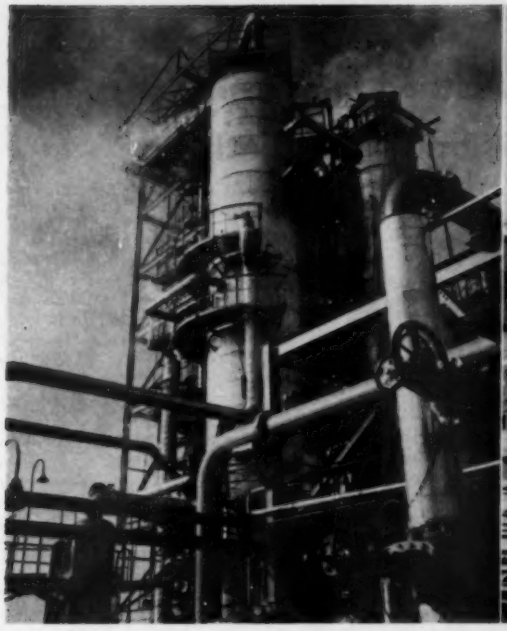
The catalytic cracking unit can process 10,000 barrels daily of 75 percent flashed distillate and 25 percent gasoline at 55 percent conversion without recycle. Company officials point to many unique features of this unit. The design, they claim, is the most compact built to date while the large capacity centrifugal type compressors and air blower installed in the plant are unique in Canada. Completely heat balanced, no preheater or catalyst coolers are provided. A major revision in the catalyst transfer method made it possible to cut the over-all height from the customary 300 feet to 118; another innovation, of injecting oil directly to the catalyst bed, eliminated the need for reactor riser, regenerator riser and reactor grid. Stripping steam is utilized to carry the spent catalyst to the external stripper; stripper vapours are isolated from the reactor and fractionator. Shape factors of swaged vessels are said to have been improved over conventional designs.

The catalyst employed in the unit is the new microspheroidal synthetic silica alumina catalyst which produces higher octane gasoline than natural catalysts and eliminates the necessity for electrical precipitators because of careful size gradation of the catalyst which circulates at the rate of 13.5 tons per minute.

The combined yield of all refinery units on an average day changes some 900,000 gallons of crude oil into: 440,000

Simplified Flow Diagram of Shell Oil Company's Montreal East Refinery, Recently Opened after Two-Year Construction and Conversion Period.





Main Fractionating Column (left) and Stripper Column (right) at Shell's Montreal East Refinery. This catalytic cracking unit was designed to reduce over-all height, 118 feet compared with conventional cat cracker heights of 300 feet. A synthetic alumina-silica, spray-dried catalyst is used.

Some indication of the complex pipe routes which connect units of Shell's Montreal East Refinery are shown here. Photo was taken from the catalytic cracker tower looking south on the light-ends treating plant. This plant opened last month after a two-year program of construction and conversion.

gallons of gasoline, 280,000 gallons of distillate fuels, 145,000 gallons of heavy fuel oil, 300,000 gallons of naphthas and 18,000 gallons of liquefied petroleum gases.

To provide the great heat required in processing operations and to produce steam power requires consumption of some four to five million cubic feet of gas and about 45,000 gallons of fuel oil daily.

The in-line blending plant can blend the six major components of motor gasoline, and tetraethyl lead, dye and inhibitor at the rate of 100,000 gallons an hour.

Refinery storage tanks which occupy the two outer thirds of the area have a total capacity to hold 104 million gallons.

New refinery installations, begun the spring of 1949 by The Fluor Corporation and Arthur G. McKee & Company include:

Construction of new tankage for an additional 26 million gallons storage capacity.

Extension of the steam generating plant and installation of new boilers to provide additional conversion of 15,000 gallons of water to steam hourly.

Installation of a 12,000-volt electrical distribution system.

Construction of the vast new maintenance shops which include lathes, jigs, test and welding equipment, a traveling overhead crane that can move a 10-machine to any point in the shop.

Remodeling of No. 1 Topping Plant and construction of a second topping plant to increase over-all refinery capacity and assure continuous operation.

Conversion of the Dubbs thermal cracking unit.

Addition to the polymerization plant.

Construction of the vacuum flasher which extracts flashed distillate from the topped crude oil and feeds this distillate to the cat cracker. (Inclusion of this unit has made possible extraction from the crude available, by ordinary distillation, of gas oils with maximum boiling point of 1000° F. in contrast to the former 700°F. limit. This in turn, has cut the residual charge to low level thermal cracking from about 45 to 15 percent of each barrel. The difference is left as a charge for the catalytic cracking facilities.

Construction of in-line blending plant.

Construction of the new catalytic cracking plant which includes a central control room for adjoining units.

Erection of cafeteria, infirmary and new administration facilities.

Completion of the new laboratories.

One of the problems of construction was the regenerator unit, for the catalytic cracking plant, which is 26 feet, 8 inches in diameter, 63 feet long and weighs 115 tons. To build it during the winter of 1949-50 so that piping could be installed early in the spring of 1950 meant either welding and construction of the giant vessel outdoors in Montreal weather or building in Canadian Vickers Company Montreal shipyards and transporting it via the St. Lawrence to the refinery site before freeze-up. It was a close race. The 115-ton vessel was completed, floated five miles down the St. Lawrence on a section of Vickers 25,000-ton floating dry-dock mere hours before the river froze over. It still had to be moved three miles overland. A 65-ton heavy-duty truck-trailer and a specially built trailer unit were used, in addition to tractors, to carry the regenerator to the refinery site. Along the line of march, special crews worked ahead and behind the procession, removing and replacing 193 utility wires.

In spite of such problems, the refinery was in continuous operation throughout the two years of construction and expansion, excepting only two weeks in August 1950 when the entire plant shut down to change over shipping facilities, connect up the in-line blending plant and to make tie-ins.

A Direct Method for Solving Flash Equilibrium Calculations

P. M. REILLY
Polymer Corporation, Limited, Sarnia, Ontario

SEVERAL articles have been published to simplify the labor of performing these calculations by the standard trial and error method. A new approach is presented by the author in which an approximate solution is found on the first trial. In most cases this answer is well within the error of the data. A method of applying a correction is also provided which gives an answer of sufficient accuracy for practically all cases.

A COMMON mathematical operation in all processes connected with the treatment of hydrocarbons is that of making equilibrium flash calculations. When light hydrocarbons are involved the analysis of the total sample is usually known in terms of the individual components along with their vaporization equilibrium constants. Under these conditions the solution invariably uses the following equation or some modification of it.

$$x_r = \frac{z_r}{p + K_r(1-p)} \qquad (1)$$

This equation is derived from a simple component balance between the two phases. It is usually used in a trial and error method in which a value of p is assumed and the x for each component determined from equation (1). Values of p are tried until $\sum_{r=1}^{r=n} x_r = 1$. Values of y for each component are then found using the relation $y_r = K_r x_r$.

Several nomographs,[1,2] graphs[2] and mechanical[4] and electrical[5] devices have been reported for shortening the labor involved in the trial and error method. The method described in this paper uses a different approach in that a value of p is obtained by a direct calculation and then the solution generally is completed by a single application of equation (1) and determination of the y values using the relation $y_r = K_r x_r$ as before.

For the relatively few cases where the value of p first obtained is not sufficiently accurate, a method is presented for correcting it.

Mathematical Derivation of Method for Finding p

The actual derivation of the equations on which the method is based is somewhat difficult to demonstrate concisely. The use of defined mathematical functions is introduced in order to prove the validity of these equations while avoiding a lengthy derivation.

The functions V_r and T are defined as follows:

$$V_r = \frac{K_r - 1}{K_r + 1} \qquad T = 2p - 1$$

Solving these identities for K_r and p respectively, they become

$$K_r = \frac{1 + V_r}{1 - V_r} \text{ and } p = \frac{1+T}{2}$$

If these expressions for K_r and p are substituted in equation (1), it becomes, on simplification:

$$x_r = \frac{z_r(1-V_r)}{1 - V_r T}$$

$$\frac{x_r}{1-V_r} = \frac{z_r}{1 - V_r T} \qquad (2)$$

Recalling that the sum of the infinite geometric series is expressed as follows:

$$a + as + as^2 \ldots\ldots \infty = \frac{a}{1-s} \text{ if } -1 < s < +1$$

it can be seen that the right side of equation (2) can be expanded into an infinite geometric series if the value of $V_r T$ is between -1 and $+1$. Inspection of the definitions of these functions shows that both V_r and T always have values in this range. $\therefore -1 < V_r T < +1$, and (2) becomes

$$\frac{x_r}{1-V} = z_r + z_r V_r T + z_r V_r^2 T^2 + \ldots\ldots \infty$$

This equation is true for each component, separately. If it is written for each of the n components and the n equations added, the result is

$$\sum_{r=1}^{r=n} \frac{x_r}{1-V_r} = \sum_{r=1}^{r=n} z_r + \sum_{r=1}^{r=n} z_r V_r T + \sum_{r=1}^{r=n} z_r V_r^2 T^2 \ldots\ldots \infty \qquad (3)$$

Rewriting the left side of (3) in terms of K_r it becomes:

$$\sum_{r=1}^{r=n} \frac{x_r}{\frac{1-K_r}{K_r+1}}$$

$$\text{or } \sum_{r=1}^{r=n} \frac{x_r(K_r+1)}{K_r + 1 - (K_r - 1)}$$

$$\text{or } \sum_{r=1}^{r=n} \frac{y_r + x_r}{2} \text{ or } 1$$

The right side of (3) is easily simplified to the following expression, since T has the same value for all components.

$$1 + T\sum_{r=1}^{r=n} z_r V_r + T^2 \sum_{r=1}^{r=n} z_r V_r^2 \ldots\ldots \infty$$

Therefore equation (3) written in simplified form is:

$$0 = T \sum_{r=1}^{r=n} z_r V_r + T^2 \sum_{r=1}^{r=n} z_r V_r^2 + T^3 \sum_{r=1}^{r=n} z_r V_r^3 \ldots\ldots \infty$$

Dividing through by T, it becomes:

$$0 = \sum_{r=1}^{r=n} z_r V_r + T \sum_{r=1}^{r=n} z_r V_r^2 + T^2 \sum_{r=1}^{r=n} z_r V_r^3 \ldots\ldots \infty$$

or in terms of K_r and p,

$$0 = \sum_{r=n}^{r=1} z_r \left(\frac{K_r - 1}{K_r + 1}\right) + (2p-1) \sum_{r=1}^{r=n} z_r \left(\frac{K_r - 1}{K_r + 1}\right)^2 + (2p-1)^2 \sum_{r=1}^{r=n} z_r \left(\frac{K_r - 1}{K_r + 1}\right)^3 \cdots \infty \quad (4)$$

This equation is exact and the series converges for all possible values of K_r and for p between 0 and 1, i.e. between the bubble point and the dew point of the mixture. These conditions cover all cases where equation (1) applies.

If a general solution of equation (4) for p were available, the exact value of p could be obtained in all cases. No such solution has been found. However, a useful approximation to the value of p can be obtained by neglecting all terms after the second of the right side of equation (4) as follows:

$$0 = \sum_{r=1}^{r=n} z_r \left(\frac{K_r - 1}{K_r + 1}\right) + (2p-1) \sum_{r=1}^{r=n} z_r \left(\frac{K_r - 1}{K_r + 1}\right)^2$$

If this is solved for p the following expression results:

$$p = \frac{\sum_{r=1}^{r=n} z_r \frac{1 - K_r}{(1 + K_r)^2}}{\sum_{r=1}^{r=n} z_r \left(\frac{1 - K_r}{1 + K_r}\right)^2} \quad (5)$$

When equation (5) is used in numerical cases for determining p, the value of p, of course, is always positive. Since it is impossible for the denominator of the right side of the equation to be negative due to the coefficient of z_r being squared, the numerator must also be positive. However, in every problem there must be one or more components for which the K value is greater than 1. For these components the expression $z_r \frac{(1 - K_r)}{(1 + K_r)^2}$ has negative values. Consequently, though the sum of the terms $z_r \frac{(1 - K_r)}{(1 + K_r)^2}$ for all the components is always positive, there will always be both positive and negative terms to be added to find it. To avoid this inconvenience the numerator of the right side of equation (5) may be rewritten as:

$$\sum_{r=1}^{r=n} z_r \left[1 + \frac{1 - K_r}{(1 + K_r)^2}\right] - \sum_{r=1}^{r=n} z_r$$

or

$$\left\{\sum_{r=1}^{r=n} z_r \left[1 + \frac{1 - K_r}{(1 + K_r)^2}\right]\right\} - 1$$

The value of the square-bracketed expression for every component will be positive.

If the following functions are defined:

$$A_r = 1 + \frac{1 - K_r}{(1 + K_r)^2}$$

$$B_r = \left(\frac{1 - K_r}{1 + K_r}\right)^2$$

Equation (5) becomes:

$$p = \frac{\left(\sum_{r=1}^{r=n} z_r A_r\right) - 1}{\sum_{r=1}^{r=n} z_r B_r} \quad (6)$$

Nomenclature

Basic Symbols

x_r	Mol fraction (or percent) of component #1 in the liquid phase at equilibrium
y_r	Mol fraction (or percent) of component #1 in the vapor phase at equilibrium
z_r	Mol fraction (or percent) of component #1 in the total mixture.
p	Mols of total liquid per mol of total mixture at equilibrium. This should not be used as a percentage.
K_r	Vaporization equilibrium constant for component #1.

Subscripts

1,2,3 etc.	Refers to the component of that number.
n	Refers to the last component of the system.
r	Refers to the general component of the n-component mixture.

Defined Functions

$$V_r = \frac{K_r - 1}{K_r + 1}$$

$$T = 2p - 1$$

$$A_r = 1 + \frac{1 - K_r}{(1 + K_r)^2}$$

$$B_r = \left(\frac{1 - K_r}{1 + K_r}\right)^2$$

$$S = \sum_{r=1}^{r=n} \frac{z_r}{p + K_r(1 - p)}$$

$$C_r = \frac{x_r(K_r - 1)}{p + K_r(1 - p)} = \frac{y_r + x_r}{p + K_r(1 - p)}$$

Basic Equations

$$\sum_{r=1}^{r=n} x_r = \sum_{r=1}^{r=n} y_r = \sum_{r=1}^{r=n} z_r = \begin{cases} 1 \text{ if mol fractions are used} \\ 100 \text{ if mol percentages are used} \end{cases}$$

$$K_r = \frac{y_r}{x_r}$$

Mathematical Derivation of Method for Correcting Value of p

A more accurate value of p may be determined as follows:

In a numerical case, when a value of p is being tried, the criterion of the suitability of the value of p being used is if

$$\sum_{r=1}^{r=n} \frac{z_r}{p + K_r(1 - p)} = 1$$

If this equation is not true, a new value of p is required.

In general, let

$$\sum_{r=1}^{r=n} \frac{z_r}{p + K_r(1 - p)} = S$$

z_r and K_r are constants in a given problem.

$$\therefore \frac{dS}{dp} = \sum_{r=1}^{r=n} \frac{-z_r(1 - K_r)}{[p + K_r(1 - p)]^2} = \sum_{r=1}^{r=n} \frac{x_r(K_r - 1)}{p + K_r(1 - p)}$$

Define $C_r = \frac{x_r(K_r - 1)}{p + K_r(1 - p)}$ or $\frac{y_r - x_r}{p + K_r(1 - p)}$

Then $$\frac{dS}{dp} = \sum_{r=1}^{r=n} C_r \quad (7)$$

The increase desired in S to correspond to the true value of p is (1—S). Consequently, the required increase in p is given approximately by

$$\Delta p = \frac{1 - S}{\sum_{r=1}^{r=n} C_r} \quad (8)$$

Tables for Finding A and B

In order to simplify the application of equation (6) to numerical problems, tables of the values of the functions A and B are given for all possible values of K.

(Editor's Note: Tables I-V appear on the next two pages.)

The functions are given to three decimal places. The use of more significant figures is not warranted due to the inherent inaccuracy of the method. The use of the tables of proportional parts which are provided where necessary for interpolation may introduce an error of 1 or 2 in the third decimal place. This introduces a negligible additional error to the method.

The tables of proportional parts are used in exactly the same manner as those presented with tables of logarithms with the important exception that for values of K between 0 and 1 the proportional part is to be subtracted from rather than added to the number obtained from the main body of the table.

TABLE I

Values of A and B as Functions of K

$$A = 1 + \frac{1-K}{(1+K)^2} \qquad B = \left(\frac{1-K}{1+K}\right)^2$$

K		.00	.01	.02	.03	.04	.05	.06	.07	.08	.09	PROPORTIONAL PARTS .001	.002	.003	.004	.005	.006	.007	.008	.009
0.0	A	2.000	1.971	1.942	1.914	1.888	.....	.....	.....	.....	.....	−3	−6	−8	−11	−14	−17	−20	−22	−25
	B	1.000	0.961	0.923	1.887	0.852	.....	.....	.....	.....	.....	−4	−7	−11	−15	−18	−22	−26	−30	−33
0.0	A	.....	.....	.....	.....	.....	1.862	1.837	1.812	1.789	1.766	−2	−5	−7	−10	−12	−14	−17	−19	−22
	B	.....	.....	.....	.....	.....	0.819	0.786	0.755	0.726	0.697	−3	−6	−9	−12	−15	−18	−21	−24	−27
0.1	A	1.744	1.722	1.702	1.681	1.662	.....	.....	.....	.....	.....	−2	−4	−6	−8	−10	−12	−14	−16	−18
	B	0.669	0.643	0.617	0.593	0.569	.....	.....	.....	.....	.....	−3	−5	−8	−10	−13	−15	−18	−20	−23
0.1	A	.....	.....	.....	.....	.....	1.643	1.624	1.606	1.589	1.572	−2	−4	−5	−7	−9	−11	−12	−14	−16
	B	.....	.....	.....	.....	.....	0.546	0.524	0.503	0.483	0.463	−2	−4	−6	−8	−10	−12	−14	−17	−19
0.2	A	1.556	1.540	1.524	1.509	1.494	.....	.....	.....	.....	.....	−2	−3	−5	−6	−8	−9	−11	−12	−14
	B	0.444	0.426	0.409	0.392	0.376	.....	.....	.....	.....	.....	−2	−3	−5	−7	−9	−10	−12	−14	−15
0.2	A	.....	.....	.....	.....	.....	1.480	1.466	1.453	1.440	1.427	−1	−3	−4	−5	−7	−8	−9	−11	−12
	B	.....	.....	.....	.....	.....	0.360	0.345	0.330	0.316	0.303	−1	−3	−4	−6	−7	−9	−10	−11	−13
0.3	A	1.414	1.402	1.390	1.379	1.368	1.357	1.346	1.336	1.326	1.316	−1	−2	−3	−4	−6	−7	−8	−9	−10
	B	0.290	0.277	0.265	0.254	0.243	0.232	0.222	0.212	0.202	0.193	−1	−2	−3	−4	−5	−7	−8	−9	−10
0.4	A	1.306	1.297	1.288	1.279	1.270	1.262	1.253	1.245	1.237	1.230	−1	−2	−3	−3	−4	−5	−6	−7	−8
	B	0.184	0.175	0.167	0.159	0.151	0.144	0.137	0.130	0.123	0.117	−1	−1	−2	−3	−4	−4	−5	−6	−7
0.5	A	1.222	1.215	1.208	1.201	1.194	1.187	1.181	1.175	1.168	1.162	−1	−1	−2	−3	−3	−4	−5	−5	−6
	B	0.111	0.105	0.100	0.094	0.089	0.084	0.080	0.075	0.071	0.067	−1	−1	−2	−2	−3	−3	−4	−4	−5
0.6	A	1.156	1.150	1.145	1.139	1.134	1.129	1.123	1.118	1.113	1.109	0	−1	−2	−2	−3	−3	−4	−4	−5
	B	0.063	0.059	0.055	0.052	0.048	0.045	0.042	0.039	0.036	0.034	0	−1	−1	−1	−2	−2	−2	−3	−3
0.7	A	1.104	1.099	1.095	1.090	1.086	1.082	1.078	1.073	1.069	1.066	0	−1	−1	−2	−2	−3	−3	−3	−4
	B	0.031	0.029	0 027	0.024	0.022	0.020	0.019	0.017	0.015	0.014	0	0	−1	−1	−1	−1	−1	−2	−2
0.8	A	1.062	1.058	1.054	1.051	1.047	1.044	1.041	1.037	1.034	1.031	0	−1	−1	−1	−2	−2	−2	−3	−3
	B	0.012	0.011	0.010	0.009	0.008	0.007	0 006	0.006	0.004	0.003	0	0	0	0	−1	−1	−1	−1	−1
0.9	A	1.028	1.025	1.022	1.019	1.016	1.013	1.010	1.008	1.005	1 003	0	−1	−1	−1	−1	−2	−2	−2	−3
	B	0.003	0.002	0 002	0.001	0.001	0.001	0.000	0.000	0.000	0.000	0	0	0	0	0	0	0	0	0

Note: The proportional parts above are to be subtracted.

TABLE II

K		.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
1.0	A	1.000	0.998	0.995	0.993	0.990	0.988	0.986	0.984	0.982	0.979
	B	0.000	0.000	0.000	0.000	0.000	0.001	0.001	0.001	0.002	0.002
1.1	A	0.997	0.975	0.973	0.971	0.969	0.968	0.966	0.964	0.962	0.960
	B	0.002	0.003	0.003	0.004	0.004	0.005	0.006	0.006	0.007	0.008
1.2	A	0.959	0.957	0.955	0.954	0.952	0.951	0.949	0.948	0.946	0.945
	B	0.008	0.009	0.010	0.011	0.012	0.012	0.013	0.014	0.015	0.016
1.3	A	0.943	0.942	0.941	0.939	0.938	0.937	0.935	0.934	0.933	0.932
	B	0.017	0.018	0.019	0.020	0.021	0.022	0.023	0.024	0.026	0.027
1.4	A	0.931	0.929	0.928	0.927	0.926	0.925	0.924	0.923	0.922	0.921
	B	0.028	0.029	0.030	0.031	0.033	0.034	0.035	0.036	0.037	0.039
1.5	A	0.920	0.919	0.918	0.917	0.916	0.915	0.915	0.914	0.913	0.912
	B	0.040	0.041	0.043	0.044	0.045	0.046	0.048	0.049	0.050	0.052
1.6	A	0.911	0.910	0.910	0.909	0.908	0.907	0.907	0.906	0.906	0.905
	B	0.053	0.055	0.056	0.057	0.059	0.060	0.062	0.063	0.064	0.066
1.7	A	0.904	0.903	0.903	0.902	0.901	0.901	0.900	0.900	0.899	0.898
	B	0.067	0.069	0.070	0.072	0.073	0.074	0.076	0.077	0.079	0.080
1.8	A	0.898	0.897	0.897	0.896	0.896	0.895	0.895	0.894	0.894	0.893
	B	0.082	0.083	0.085	0.086	0.088	0.089	0.090	0.092	0.093	0.095
1.9	A	0.893	0.892	0.892	0.892	0.891	0.891	0.890	0.890	0.890	0.889
	B	0.096	0.098	0.099	0.101	0.102	0.104	0.105	0.107	0.108	0.110

TABLE III

K		.00	.02	.04	.06	.08
2.0	A	0.889	0.888	0.888	0.887	0.886
	B	0.111	0.114	0.117	0.120	0.123
2.1	A	0.886	0.885	0.884	0.884	0.883
	B	0.126	0.129	0.132	0.135	0.138
2.2	A	0.883	0.882	0.882	0.881	0.881
	B	0.141	0.144	0.146	0.149	0.152
2.3	A	0.881	0.880	0.880	0.880	0.879
	B	0.155	0.158	0.161	0.164	0.167
2.4	A	0.879	0.879	0.878	0.878	0.878
	B	0.170	0.172	0.175	0.178	0.181
2.5	A	0.878	0.877	0.877	0.877	0.877
	B	0.184	0 186	0.189	0.192	0.195
2.6	A	0.877	0.876	0.876	0.876	0.876
	B	0.198	0.200	0.203	0.206	0.208
2.7	A	0.876	0.876	0.876	0.875	0.875
	B	0.211	0.214	0.216	0.219	0.222
2.8	A	0.875	0.875	0.875	0.875	0.875
	B	0.224	0.227	0.230	0.232	0.235
2.9	A	0.875	0.875	0.875	0.875	0.875
	B	0.237	0.240	0.242	0.245	0.248
3.0	A	0.875	0.875	0.875	0.875	0.875
	B	0.250	0.252	0.255	0.257	0.260
3.1	A	0.875	0.875	0.875	0.875	0.875
	B	0.262	0.265	0.267	0.270	0.272
3.2	A	0.875	0.875	0.875	0.876	0.876
	B	0.274	0.277	0.279	0.281	0.283
3.3	A	0.876	0.876	0.876	0.876	0.876
	B	0.286	0.288	0.291	0.293	0.295
3.4	A	0.876	0.876	0.876	0.876	0.876
	B	0.298	0.300	0.302	0.304	0.306
3.5	A	0.877	0.877	0.877	0.877	0.877
	B	0.309	0.311	0.313	0.315	0.317
3.6	A	0.877	0.877	0.877	0.878	0.878
	B	0.320	0.322	0.324	0.326	0.328
3.7	A	0.878	0.878	0.878	0.878	0.878
	B	0.330	0.332	0.334	0.336	0.338
3.8	A	0.878	0.879	0.879	0.879	0.879
	B	0.340	0.342	0.344	0.346	0.348
3.9	A	0.879	0.879	0.880	0.880	0.880
	B	0.350	0.352	0.354	0.356	0.358

Numerical Calculation

The method will be illustrated by the following example:

Find the mol fraction of liquid (p) which is present if a mixture of the following over-all composition is brought to equilibrium under conditions which result in the given K values for the components. Also find the mol fraction of each component in the liquid phase (x_r) and in the vapor phase (y_r). (See Table 1.)

TABLE 1

Component	z_r	K_r
1	0.097	5.478
2	0.351	1.395
3	0.214	0.823
4	0.199	0.504
5	0.139	0.042

Solution

The first step is to determine for each component the values of the A and B functions from the tables. When found, A_r and B_r are separately multiplied by z_r and the values of

TABLE IV

K		.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	PROPORTIONAL PARTS .01	.02	.03	.04	.05	.06	.07	.08	.09
4	A	0.880	0.881	0.882	0.882	0.883	0.884	0.885	0.886	0.887	0.888	0	0	0	0	1	1	1	1	1
	B	0.360	0.370	0.379	0.388	0.396	0.405	0.413	0.421	0.429	0.437	1	2	3	4	4	5	6	7	8
5	A	0.889	0.890	0.891	0.892	0.893	0.894	0.894	0.895	0.896	0.897	0	0	0	0	1	1	1	1	1
	B	0.444	0.452	0.459	0.466	0.473	0.479	0.486	0.492	0.498	0.504	1	1	2	3	3	4	5	5	6
6	A	0.898	0.899	0.900	0.900	0.901	0.902	0.903	0.904	0.905	0.906	0	0	0	0	0	0	1	1	1
	B	0.510	0.516	0.522	0.527	0.532	0.538	0.543	0.548	0.553	0.558	1	1	2	2	3	3	3	4	5
7	A	0.906	0.907	0.908	0.908	0.909	0.910	0.911	0.912	0.912	0.913	0	0	0	0	0	0	1	1	1
	B	0.562	0.567	0.572	0.576	0.580	0.585	0.589	0.593	0.597	0.601	0	1	1	2	2	3	3	3	4
8	A	0.914	0.914	0.915	0.916	0.916	0.917	0.918	0.918	0.919	0.919	0	0	0	0	0	0	0	0	1
	B	0.605	0.609	0.612	0.616	0.620	0.623	0.627	0.630	0.634	0.637	0	1	1	1	2	2	2	3	3
9	A	0.920	0.921	0.921	0.922	0.922	0.923	0.924	0.924	0.925	0.925	0	0	0	0	0	0	0	0	0
	B	0.640	0.643	0.646	0.649	0.652	0.655	0.658	0.661	0.664	0.667	0	1	1	1	2	2	2	2	3
10	A	0.926	0.926	0.927	0.927	0.928	0.928	0.929	0.929	0.930	0.930	0	0	0	0	0	0	0	0	0
	B	0.669	0.672	0.675	0.677	0.680	0.682	0.685	0.687	0.690	0.692	0	0	1	1	1	2	2	2	2
11	A	0.931	0.931	0.931	0.932	0.932	0.933	0.933	0.934	0.934	0.934	0	0	0	0	0	0	0	0	0
	B	0.694	0.697	0.699	0.701	0.703	0.706	0.708	0.710	0.712	0.714	0	0	1	1	1	1	2	2	2
12	A	0.935	0.935	0.936	0.936	0.936	0.937	0.937	0.938	0.938	0.938	0	0	0	0	0	0	0	0	0
	B	0.716	0.718	0.720	0.722	0.724	0.726	0.727	0.729	0.731	0.733	0	0	1	1	1	1	1	1	2
13	A	0.939	0.939	0.939	0.940	0.940	0.941	0.941	0.941	0.942	0.942	0	0	0	0	0	0	0	0	0
	B	0.735	0.736	0.738	0.740	0.742	0.743	0.745	0.746	0.748	0.750	0	0	1	1	1	1	1	1	2
14	A	0.942	0.943	0.943	0.943	0.944	0.944	0.944	0.944	0.945	0.945	0	0	0	0	0	0	0	0	0
	B	0.751	0.753	0.754	0.756	0.757	0.759	0.760	0.761	0.763	0.764	0	0	0	1	1	1	1	1	1
15	A	0.945	0.946	0.946	0.946	0.946	0.947	0.947	0.947	0.948	0.948	0	0	0	0	0	0	0	0	0
	B	0.766	0.767	0.768	0.770	0.771	0.772	0.774	0.775	0.776	0.777	0	0	0	1	1	1	1	1	1
16	A	0.948	0.948	0.949	0.949	0.949	0.949	0.950	0.950	0.950	0.950	0	0	0	0	0	0	0	0	0
	B	0.779	0.780	0.781	0.782	0.783	0.784	0.786	0.787	0.788	0.789	0	0	0	0	1	1	1	1	1
17	A	0.951	0.951	0.951	0.951	0.952	0.952	0.952	0.952	0.952	0.953	0	0	0	0	0	0	0	0	0
	B	0.790	0.791	0.792	0.793	0.794	0.796	0.797	0.797	0.798	0.800	0	0	0	0	1	1	1	1	1
18	A	0.953	0.953	0.953	0.954	0.954	0.954	0.954	0.954	0.953	0.955	0	0	0	0	0	0	0	0	0
	B	0.800	0.802	0.802	0.804	0.804	0.805	0.806	0.807	0.808	0.809	0	0	0	0	0	1	1	1	1
19	A	0.955	0.955	0.955	0.956	0.956	0.956	0.956	0.956	0.957	0.957	0	0	0	0	0	0	0	0	0
	B	0.810	0.811	0.812	0.813	0.814	0.814	0.815	0.816	0.817	0.818	0	0	0	0	0	1	1	1	1

The proportional parts above are to be added.

TABLE V

K	A	B
20 to 21	0.958	0.819+0.0078 (K-20)
21 to 22	0.960	0.826+0.0072 (K-21)
22 to 23	0.961	0.834+0.0066 (K-22)
23 to 24	0.962	0.840+0.0061 (K-23)
24 to 25	0.964	0.846+0.0056 (K-24)
25 to 26	0.965	0.852+0.0052 (K-25)
26 to 27	0.966	0.857+0.0048 (K-26)
27 to 28	0.967	0.862+0.0045 (K-27)
28 to 29	0.968	0.867+0.0043 (K-28)
29 to 30	0.969	0.871+0.0042 (K-29)
30 to 40	0.970+0.0007 (K-30)	0.875+0.0030 (K-30)
40 to 50	0.977+0.0004 (K-40)	0.905+0.0018 (K-40)
50 to 60	0.981+0.0003 (K-50)	0.923+0.0012 (K-50)
60 to 70	0.984+0.0002 (K-60)	0.936+0.0009 (K-60)
70 to 80	0.986+0.0002 (K-70)	0.944+0.0007 (K-70)
80 to 90	0.988	0.951+0.0005 (K-80)
90 to 100	0.989	0.956+0.0004 (K-90)
100	0.990	0.961
100 to 1000	0.990+0.00001 (K-100)	0.996 For K >100
1000	0.999	1.000 $B = 1 - \frac{4}{K}$
∞	1.000	

$$\sum_{r=1}^{r=n} z_r A_r \text{ and } \sum_{r=1}^{r=n} z_r B_r$$

determined by addition, as shown in Table 2.

TABLE 2

Component	K_r	A_r	B_r	z_r	$z_r A_r$	$z_r B_r$
1	5.478	0.894	0.478	0.097	0.0867	0.0464
2	1.395	0.932	0.028	0.351	0.3271	0.0098
3	0.823	1.053	0.010	0.214	0.2253	0.0021
4	0.504	1.219	0.109	0.199	0.2426	0.0217
5	0.042	1.882	0.845	0.139	0.2616	0.1175
					1.1433	0.1975

Using equation (6),

$$\frac{1.1433 - 1.0000}{0.1975} = 0.726$$

TABLE 3

(r)	(1) K_r	0.274K	(2) 0.274K+0.726	(3) z_r	(3)÷(2) x_r	(1)x(3)÷(2) y_r	Corrected Values x_r	Corrected Values y_r
1	5.478	1.5010	2.2270	0.097	0.044	0.239	0.044	0.241
2	1.395	0.3822	1.1082	0.351	0.317	0.442	0.316	0.447
3	0.823	0.2255	0.9515	0.214	0.225	0.185	0.224	0.187
4	0.504	0.1381	0.8641	0.199	0.230	0.116	0.229	0.117
5	0.042	0.0115	0.7378	0.139	0.188	0.008	0.187	0.008
	.....	.....	.....	.....	1.004	0.990	1.000	1.000

The calculation is then completed in the usual manner. (See Table 3.)

The values of x_r and y_r shown as "corrected values" are obtained by dividing the uncorrected ones by $\Sigma\ x_r$ and $\Sigma\ y_r$ respectively, in this case 1.004 and 0.990.

Discussion of Accuracy of Solution

The ratio of y_r to x_r as calculated above may be compared with value of K_r given as shown in Table 4.

TABLE 4

(r)	Corrected Values y_r	Corrected Values x_r	K_r	$\left(\frac{y_r}{K_r x_r}\right)$
1	0.241	0.044	5.478	1.000
2	0.447	0.316	1.395	1.014
3	0.187	0.224	0.823	1.014
4	0.117	0.229	0.504	1.014
5	0.008	0.187	0.042	1.019

The maximum error is 1.9 percent and it is obvious that a significant part of this arises from the large percentage error in rounding off y_5 to three significant figures. The true error of the method seems to be 1.4 percent. This compares very favorably with the accuracy with which the K values are known. This is seldom, if ever, better than 5 percent without direct experiment with the system being studied. Most published K values are accurate to no better than 10 percent. Consequently, in this case, the error of the method is well within the error of the information.

The method is more accurate when p is in the neighborhood of 0.5. For very low or very high values of p the accuracy in general drops off. Unfavorable cases also occur when a component has a very high or very low K value and there is not a roughly equal quantity present of another component whose K value is near the reciprocal of that of the first component.

The example shown above is a rela-

TABLE 5

(r)	Uncorrected		$y_r - x_r$	$0.2741K + 0.726^a$	C_r
	y_r^a	x_r^a			
1	0.339	0.044	0.195	2.2270	0.088
2	0.442	0.317	0.125	1.1082	0.113
3	0.185	0.225	−0.040	0.9515	−0.042
4	0.116	0.230	−0.114	0.8641	−0.133
5	0.008	0.188	−0.180	0.7375	−0.244
	.....	1.004	.....	.....	−0.217

[a] Figures in these columns are recopied from table 3.

tively unfavorable case in both respects.

The method is sufficiently accurate for all purposes in the majority of practical cases. The extent of the error which occurs can always be judged by the magnitude of the departures of Σx and Σy from 1.000.

Correction to Value of p

For unfavorable cases or where absolute mathematical accuracy is required, equation (8) may be used to determine a correction for p. It is applied as in Table 5 to the example being studied.

Then according to equation (8)

$$\Delta p = \frac{-0.004}{-0.217} = +0.018$$

Since this correction is to be added to p, the corrected value of p is 0.744.

If the values of y_r had not been already calculated, it may have been more convenient to use the alternative form of the definition of C_r which has the expression $x_r(K_r - 1)$ in the numerator in place of $y_r - x_r$.

When equation (1) is applied as was done in Table 3, using the new value for p, the uncorrected values of x_r and y_r which are obtained are as shown in Table 6.

TABLE 6

(r)	x_r	y_r
1	0.045	0.248
2	0.319	0.445
3	0.224	0.184
4	0.228	0.115
5	0.184	0.008
	1.000	1.000

In the infrequent cases where this correction does not give a sufficiently accurate result, it may be applied a second time, calculating the C_r values from the figures obtained in the application of equation (1) after the first correction.

This method of correcting the value of p can also be used with a purely trial and error solution in which the first trial value for p is guessed. Of course, the guessed value of p will not in general be as accurate as that determined through the use of the tables and consequently there is greater likelihood that the correction will have to be applied more than once.

Use of Mol % Analyses

All calculations shown may be performed in exactly the same manner if mol % figures are used throughout for x, y and z but if p is maintained as a mol fraction.

When used in this type of calculation, equations (6) and (8) are modified as follows:

$$p = \frac{\left(\sum_{r=1}^{r=n} z_r A_r\right) - 100}{\sum_{r=1}^{r=n} z_r B_r} \qquad (6a)$$

$$\Delta p = \frac{100 - S}{\sum_{r=1}^{r=n} C_r} \qquad (8a)$$

Conclusions

The methods presented in this paper are applicable to nearly all equilibrium flash calculations of the type described, and in most cases very considerably reduce the number of trials required.

Certain recently published tables of vaporization equilibrium constants relate them not only to temperature and pressure, but also to the average boiling points of the liquid and vapor phases.[5] The solution of problems using these sources of information is necessarily a trial and error procedure but by using the methods described the number of trials can be significantly reduced.

REFERENCES

[1] Scheibel, E. G.; Petroleum Refiner 27, 392 (1948).

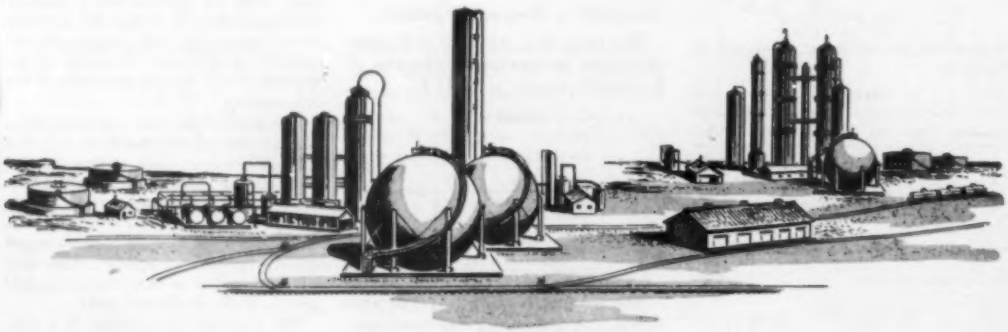
[2] Poettmann, F. H., and Rice, R. B.; Petroleum Refiner 26, 824 (1947).

[3] Donnell, J. W., and Turbin, K.; Petroleum Refiner, Vol. 29, No. 10, 109 (1950).

[4] Thomas, W. A., Fussman, F., and Delaney, W. H.; Petr. Processing 5, 948 (1950).

[5] Liquid-Vapour Equilibria in Mixtures of Light Hydrocarbons (polyco Data)—M. W. Kellogg Co.

* * *



PRESSURE vessels in process plants are subjected to varied conditions of operating temperature and pressure. The operating temperatures may be anywhere from extreme low levels to the maximum that our construction materials will permit. Pressures may be high vacuum or several thousand pounds per square inch, or anywhere between. Vessels when placed in service or shut down commonly undergo large changes in temperature or pressure, or both. These changes induce stresses in the support structures through variations in expansion between support and vessel. Such stresses may on occasion be quite large—in some cases support failures have occurred.

Comparatively little information has been published on this important subject, and it is thought that this rather thorough study will be welcomed by those in the industry directly concerned with pressure vessel design, fabrication, inspection, and maintenance. This is the first of a four-part series to appear in Petroleum Refiner.

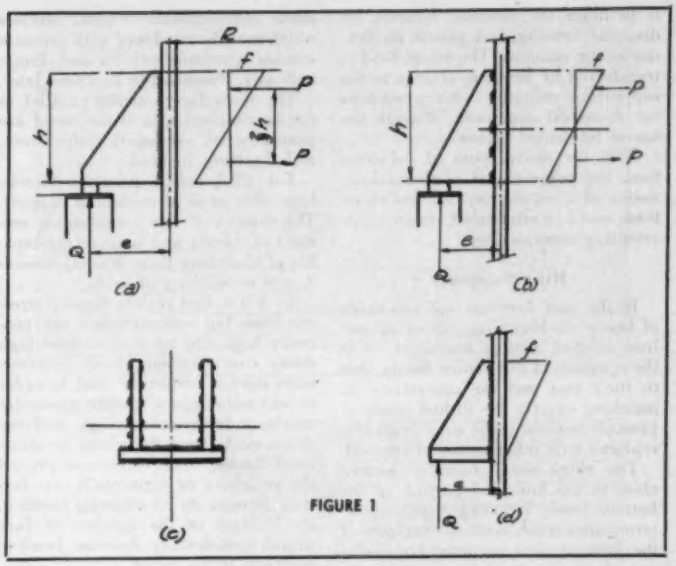


FIGURE 1

Supports for Vertical Pressure Vessels

PART I

F. E. WOLOSEWICK
Structural Engineer, Chicago

VERTICAL pressure vessels in process industries are supported in one of four ways: by columns attached to the vessels, by supporting vessels on circular rings, by means of brackets or lugs attached to the vessel and resting on concrete or steel framings, or by using circular skirts.

Column Supports

Columns equally spaced around the periphery of the vessel are generally used for supporting small-sized pressure vessels, operating at moderate temperatures. This construction is rarely used for larger vessels, although some of ten feet in diameter, operating at or about 220° F., have been supported in this manner.

This method of support has certain desirable features. The effects of diametral expansion of the pressure vessel on the supporting columns can be evaluated with a reasonable degree of accuracy. Through a judicious selection of suitable structural shapes, eccentricity of loads can be kept at a minimum, causing a more favorable stress distribution in the vessel wall. Also the effects of diametral expansion can be neutralized or minimized through correct use of eccentricities.

Moments in structural supporting members and the pressure vessels due to thermal expansion can be made zero under operating conditions by prestressing the columns. This can be done quite readily by providing suitable struts at the bottom of the columns, whose lengths are longer by the amount of diametral expansion, and forcing them into position.

In the designs of such structural supports, all bracing must be excluded. Wind loads and pipe thrusts must be resisted by the supporting columns in flexure. Considerable judgment is needed to properly evaluate the degrees of restraint at the bottom of supporting columns, and also to proportion the horizontal shears correctly, in order not to design too rigid supporting members.

Instead of using flexible columns, with assumed degree of fixity at the vessel and at the concrete support, two additional alternates are possible:

1) Use columns fixed at the base, provide lugs which will transfer the load eccentrically from the vessel wall to the supporting columns. By using lubricated bronze plates, frictional thrusts can be kept quite low. Any diametral expansion, will either deflect the columns if they are limber, to the full amount of diametral expansion of the vessel, or to some intermediate position, consistent with the applied force at the top.

2) The alternate most often used,

is to brace the columns securely by diagonal bracing, and permit no flexure in the columns. The vessel load is transferred by brackets or lugs to the supporting columns, with provisions for diametral expansion, through the use of lubricated surfaces.

With the above types of construction, the conventional framings consisting of rigid steel or concrete structures could be eliminated, thereby representing some savings.

Ring Supports

In the past, frequent use was made of heavy circular rings, either of cast iron or steel, cast or machined, to fit the contours of the bottom heads. Due to their cost and the uncertainty of matching exactly the dished heads of pressure vessels, rings were gradually replaced with other means of support.

The rings were generally located close to the knuckled portion of the bottom head, inducing highly indeterminate stresses at contact surfaces. If the surfaces were not fitted truly, diametral expansions due to temperature were not uniform, and over a period of time, these vessels were found to be out of plumb. Any piping attached to these vessels would be displaced, causing additional forces on the connecting pieces of equipment.

Lug Supports

Brackets or lugs offer one of the least expensive and most direct ways of supporting pressure vessels. They can absorb diametral expansions readily by sliding over greased or bronze plates, are easily attached to the vessel, by minimum amounts of welding, and are readily levelled or shimmed in the field.

These types of eccentric supports induce compressive, tensile and shear forces in the walls of pressure vessels. The tensile and compressive forces cause indeterminate flexural stresses which must be combined with pressure stresses circumferentially and longitudinally. These will be discussed later.

The shear forces acting parallel to the longitudinal axis of the vessel are generally of secondary importance, and therefore ignored.

For thick-walled pressure vessels, lugs offer an ideal method of support. The thick wall has considerable moment of inertia and is therefore capable of absorbing these flexural stresses due to eccentricity of loads.

In thin-walled vessels, flexural stresses from lug concentrations are generally high, and because of these high stress concentrations, such constructions are not frequently used. In order to take advantage of certain economies resulting from use of lugs, stiffener rings, made from flat plates or structural shapes, either continuous around the periphery or segmentally, are frequently used. As an alternate solution, an increase in the number of lugs would considerably decrease bending moments in the vessel.

Lugs when designed without any consideration of their effects on the walls of the pressure vessels, have been known to deform them considerably. Such wall deformations have caused angular rotations of the lugs, throwing the resultant of the vertical loads practically to the edge of the lugs. All such recorded instances showed considerable structural damage to the supporting beams.

In concrete beams spalling was serious, and steel beams had noticeable torsional rotations. Fortunately, the judgment of structural engineers in adding additional stirrups in concrete beams, and stiffners in steel at points of high concentrations, provided a reasonable margin of safety. To the writer's knowledge no structural failures were ever recorded.

Another expedient frequently used is to provide a narrow bearing area under the lug on the center line of the beam, with sufficient clearance between the vertical webs of the lugs and the support, so that in case large angular rotations occur, no dangerous bearing pressure would be developed.

Skirt Supports

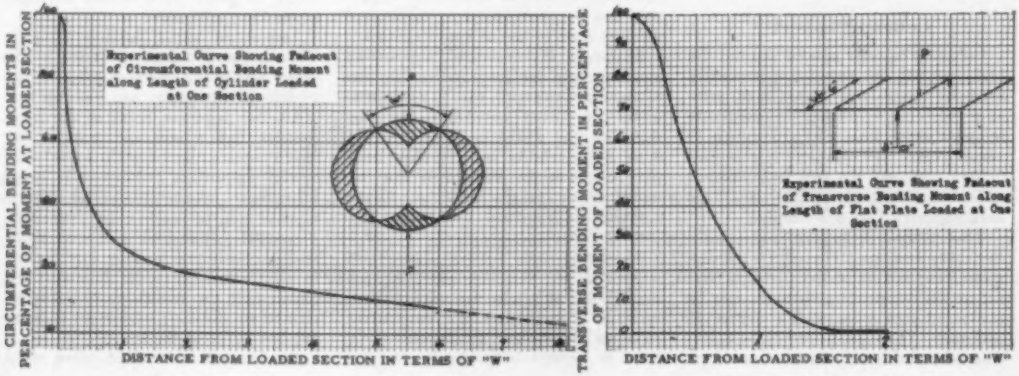
Skirts of thicknesses equal to or less than the wall of the pressure vessels are used extensively for all types and various diameters of pressure vessels. Variations of temperature through the skirt, and effects of pressure rarely enter into stress calculations of the skirt itself, although the code authorities indirectly suggest that such stresses should be investigated.

Skirts have been used successfully on pressure vessels more than 20 feet in diameter, and operating at temperatures as high as 1000° F. At such temperatures the diametral expansion would be approximately two inches. The effects of temperature stresses in skirts will be discussed later.

Skirts are placed either on the outside of the vessel, or are flush with the wall, and welded directly thereto. In the first type, the weld is subject to shear, while in the second, to direct compression from the gravity load, and to tension from wind forces. Secondary bending stresses are developed in the welds due to diametral expansion of the vessel, and variations of temperature through the skirt longitudinally. The stresses are of high order of magnitude.

The bottom part of the skirt is provided with a narrow plate, or with angles, sufficiently wide for distributing direct loads to supporting beams or concrete foundations. Anchor bolts equally spaced of nominal size are used for larger vessels where overturning is not possible, which hold the vessel to the foundation. For tall lim-

Figure 2


CIRCUMFERENTIAL BENDING MOMENTS IN PERCENTAGE OF MOMENT AT LOADED SECTION
Experimental Curve Showing Fadeout of Circumferential Bending Moment along Length of Cylinder Loaded at One Section
DISTANCE FROM LOADED SECTION IN TERMS OF "W"
TRANSVERSE BENDING MOMENT IN PERCENTAGE OF MOMENT OF LOADED SECTION
Experimental Curve Showing Fadeout of Transverse Bending Moment along Length of Flat Plate Loaded at One Section
DISTANCE FROM LOADED SECTION IN TERMS OF "W"

ber vessels, substantial bolts are required, to resist not only the wind forces, but also pipe thrusts.

Lug Reactions on Vessels

Assuming the vessel to be supported on lugs, then insofar as vertical loads are considered, each lug is assumed to carry its proportional share of the load. This assumption is correct if the lugs rest on beams having the same flexural rigidity, or when supported on columns. This condition would not be true, when beams having different stiffness ratios are used.

The problem of evaluating the correct part of the load to be carried by beams of varying stiffness would be to determine the proportional relationships between deflections of the various supporting beams. Intermediate beams having greater deflections for the same load will not carry as much as the more rigid ones. Arbitrary apportioning of the total load by the number of supports, without consideration of deflections of supporting beams, will generally lead to faulty structural design of the support.

From Figure 1, let Q be the load carried by the lug, and e is the eccentricity of the load, conveniently considered to the center line of the vessel wall. Moment of load relative to the center line of the wall is then equal to Qe. This moment is resisted by a couple P acting through a lever arm $\frac{2h}{3}$. This is the conventional linear stress distribution.

Equating moments, $Qe = \frac{2h}{3} \times P$ (1)

Or

$$P = \frac{3Qe}{2h} \text{ for a lug with a single rib} \quad (2)$$

$$P = \frac{3Qe}{4h} \text{ for a lug with two ribs} \quad (3)$$

The force P as used here is the resultant, and is acting through the center of gravity of the stress triangle. To determine the intensity and variation of the unit stress, it is necessary to set P equal to the pressure of the resisting triangle. Hence

$$P = \frac{fht}{4}, \quad (4)$$

$$f = \frac{4P}{ht}$$

where f is the unit intensity of stress on the pressure vessel wall;
h is the height of the lug,
t, thickness of the rib, or welds, depending on manner of welding.

Under certain conditions, instead of welding the lug continuously to the shell, intermittent welding as shown in Figure 1b is used. Assuming center of rotation to occur about the center of gravity of the welds, the moment of the load Q is equated to the resisting moment of the entire weld group. Or

$$Qe = \frac{2\Sigma d_n^2 fmt}{h} \quad (5)$$

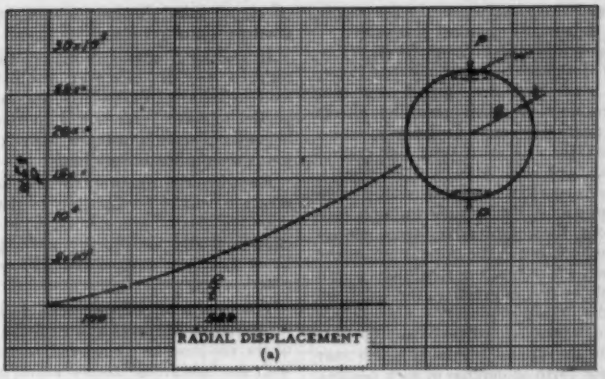
Or

$$f = \frac{Qeh}{2\Sigma d_n^2 mt} \quad (6)$$

where d_n is the distance to the "nth" weld, and must be summed for the entire group. If welds are on both sides of the rib, these must also be taken into consideration, m is the length of the weld, t is thickness of the welds bearing against the wall.

Lugs sometimes have the lower portion of the bearing plate welded to the shell as shown in Figure 1c. It would be incorrect to disregard the stiffening effects of the mass of welding holding the bearing plate to the vessel wall. If no welds are provided, the case would be comparable with the ones discussed above.

For the latter condition, it is necessary to evaluate the resistance to rotation of the entire welding assembly, and utilize the conventional flexural equation for determining the stress at critical points. From stresses so determined, the intensity of pressure on the shell can be obtained.



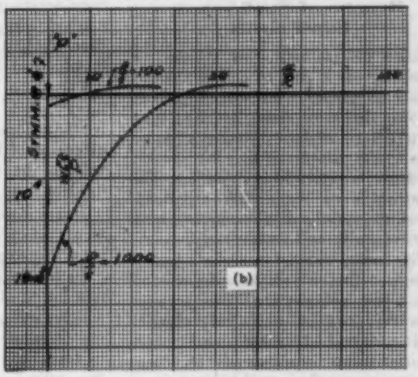


Figure 3 (above and at right). Displacements of Cylinders (from Analyses m by Shao Wen Yuan).

Another stress distribution used by some design engineers is that shown in Figure 1d.[1] The center of rotation is assumed to occur some distance above the bottom weld, with the linear variations to the top. This distribution will give smaller stresses on weld, and on the vessel wall. This assumption does not seem to agree with the usual behavior of displaced walls. It would appear that center of rotation is more nearly towards the center of gravity of the weld group. Perhaps the true distribution is somewhere between the range indicated, and experimental data could answer this question better than any amount of discussion.

The above methods of approach are conventional ones, familiar to every structural engineer, and are used repeatedly in all structural designs.

Of the horizontal forces resisting the moment due to eccentricity of reaction, the lower ones, that is the tensile part of the couple, are the more critical ones, since they induce hoop stresses in the walls of the pressure vessel. These hoop stresses are additive to those from internal pressure. The ef-

fects of compressive part of the couple are resisted by internal pressure.

Generally these hoop forces from well designed lugs are not too large, and since they are spread over considerable area, their resulting effects are generally small. In limiting cases, especially with short lugs, heavy loadings, used with thin walled vessels, hoop forces can reach reasonably large proportions. Under such limiting conditions, the compressive forces can induce buckling in the upper parts of the vessel. These limiting conditions would rarely be met in practice; the judgment of the design engineer would exclude their usages, regardless of any approximate or rational methods which may be put forth in defense of such designs.

Resume of Studies and Experiments

Exact determination of stresses in pressure vessels due to concentrations from lugs has not been solved to date.

Using theory of elasticity Shao Wen Yuan[2] determined the differential equations for conditions of two loads, 180° apart on infinitely long cylinders. The equation is of the eighth order expressing radial displacements both longitudinally and transversely.

The concentrated force was assumed to be distributed over an infinitesimal area. The concentrated forces were later replaced by uniformly distributed ones, which subsequently were reduced to an infinitesimal. This condition was made possible by representing the force in longitudinal direction and in the circumferential, by Fourier integral and by Fourier series respectively.

The results of this theoretical analysis can be evaluated by noting the graphs showing longitudinal and circumferential displacements. Thus in Figure 3a, the maximum displacements at the point of load one in the radial direction, while Figure 3b shows the extent of the longitudinal displacements.

It will be noticed from Figure 3a that large displacements are possible for large ratios of R/t, where R is the mean radius, and t is the thickness of the cylinder. For the more conventional pressure vessels, where the ratio of R/t is under 100, the radial displacements are considerably smaller. For a value of R/t of 100, at temperature of 650°, where $t = 1$ inch, the maximum radial displacement is about "P ÷ 48,000" expressed in inches. As the ratio of R/t begins to decrease, the effects of radial displacement begin to decrease quite rapidly.

In the longitudinal direction, theoretically the displacement would extend to infinity. Practically, its value begins to have secondary importance beyond reasonable distance away from point of application of load.

Knowing the equation for displacements it would be possible to determine the maximum moments, both circumferentially and longitudinally. From moments, stresses could be computed.

For condition of practical design, the variation of forces along the length of the lug must be considered, together with any additional forces which may be developed by other forces. Such considerations create difficult mathematical complications for which simpler evaluations have not been determined as yet.

Theory of Beams on Elastic Foundations[3] offers considerable possibilities for solutions of such problems. The extension of this powerful tool of analysis to the more practical problems has not been published to date.

Roark conducted two sets of experiments on cylinders under the action of concentrated forces.[4, 5]

In his first series of tests, the effective longitudinal zone of the cylinder which carries the major share of bending circumferentially was determined in terms of the point of inflection of the cylinder under test. Additional tests were made on a flat plate, 6 inches wide and 3 feet long, to determine the effective width of the plate under the action of centrally applied load P. Results of these experiments are shown in Figure 2.

It is interesting to note the difficulties encountered with such measurements. Quoting from his first article:

"It is apparent from the methods employed for comparison of bending moments is rather crude. Moments can be compared on the basis of center deflection only when the distribution of moments across the span is identical, and there is no justification for assuming that this was the case in the loading considered. On the other hand, the span employed was so short in comparison with w* that it would seem that differences in moment distribution could hardly introduce any serious error. It is believed that when used simply as a means of comparing moments at different points along the length of the cylinder, the deflection method employed was sufficiently accurate. A graver error seems probable in connection with the determination of w. The variation of circumferential moment along the girth of the cylinder is quite rapid, and it is evidently not possible to determine with accuracy the point of inflection by measurement deflections. The results obtained in successive tests and in measurements to right and left of the loaded element were however consistent, and it is not believed that the value obtained for w can be in error by more than one inch, or about 10 percent.

"The area under this curve would indicate half the length of the pipe, that could be regarded as contributing the entire full ring bending moment to the stiffening ring. As seen the curve does not reach zero, even at the extreme ends of cylinder some bending persisted. But for cylinders of indefinite length, the fade out would be more rapid, and it is probably safe to take as the area under the true fade out curve, the area under the graph extended as shown by the dotted line. This area is approximately $1.3w$, and since it represents conditions on one side of the ring, it is necessary to double this value, making the length of the pipe that can be regarded as contributing the free bending moment to the stiffening ring $2.6w$." These are shown in Figures 2 and 3.

It will be observed from study of graphs, that the range of displacements is centered around a narrow zone, on each side of the center line of the load.

In his second paper, Roark[5] studied the stress distribution, on two cylinders, one of 0.129 inches in thickness, 23 inches long, the other of 0.330 and 23.5 inches in diameter, under the action of two forces, 180° apart. Results of his experiment were evaluated into an empirical equation for determination of stress both longitudinally and circumferentially,[12] under the action of a force over a small radius. It is interesting to note that the stress distribution is confined to narrow zones longitudinally, but does have a fair degree of spread in the circumferential direction. Results of these tests led Roark to conclude, that "both stiffness and strength of thin cylindrical shells under concentrated loads is probably greater than would be normally supposed."[5]

Studies of the Department of Interior,[6] on penstocks practically corroborate the above, but were extended further to indicate specific zones of the shell which may be used with stiffening rings.

End of Part I. Part II will follow in an early issue.

* The term "w" as used by Roark should not be confused with "w" used in the latter part of the article. Roark uses "w" to define either the width of the plate, or distance between inflection points on a cylinder. As used in the latter part of the article, "w" defines the radial expansion, either due to pressure, or temperature.

NOTE

The author, Mr. Wolosewick, is connected with Sargent and Lundy, Engineers, Chicago.

BIBLIOGRAPHY

[1] Hauf, "Design of Steel Buildings."

[2] Shao Wen Yuan, "Thin Cylindrical Shells Subjected to Concentrated Loads," Quarterly of Applied Mathematics, Brown University, Providence, R. I.

[3] Hetenyi, Miklos, "Beams on Elastic Foundations," University of Michigan Press.

[4] Study of Circumferential Bending of Pipes and Cylindrical Containers," R. J. Roark, University of Wisconsin, Engineering Experiment Station.

[5] "Strength and Stiffness of Cylindrical Shells under Concentrated Loadings," American Society of Mechanical Engineers, Journal of Applied Mechanics, Vol. 2, No. 4, p. A147, 1935.

[6] Penstock Analyses and Stiffner Design, Department of Interior.

[12] Roark, "Formulas for Stress and Strain."

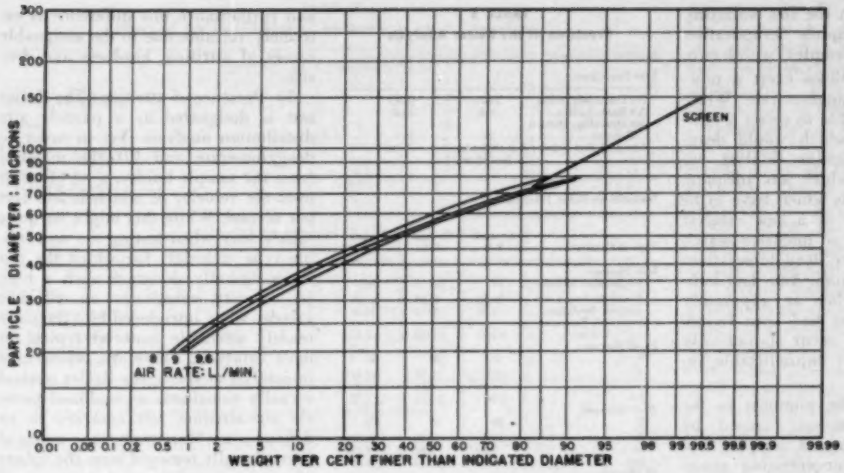


Figure 2. Effect of Air Rate in Air Elutriation.

IMPROVED METHODS FOR—

The Particle Size Analysis of Fluid Cracking Catalysts

Part II

F. EMERSON IVEY, JR.
The Davison Chemical Corporation, Baltimore

IN PART II of this three-part article, the precision of the Roller test as applied to fluid cracking catalysts is shown to vary from ±2.1 percent at the 0-20 micron level to ±7.6 percent at 80+ micron level. Data are also presented to indicate the lack of accuracy of the method. The causes of these undesirable characteristics are discussed together with the means used to improve them. The use of air of 60 percent relative humidity at a 9 liter per minute rate, and a fritted glass aeration tube were found to increase the precision to ±0.6 percent at the 0-20 micron level and ±1.7 percent at the 80+ micron level, mainly by eliminating attrition, agglomeration, and electrostatic retention. Humidification of the sample prior to testing was found to be of no benefit.

Particle Size Analysis in the Sub-Sieve Range

Practically all of the methods for examining particle size distribution in the sub-sieve range utilize a fluid-dynamic system, the action of which is expressed by the familiar Stokes Law equation:

$$V = \frac{D^2 g\,(\rho s - \rho)}{18\,\mu}$$

where V = relative velocity between the fluid and the particle in centimeters per second
D = particle diameter in centimeters
g = acceleration of gravity in centimeters per second per second
ρs = density of the particle in grams per cubic centimeter
ρ = density of the elutriating fluid in grams per cubic centimeter
μ = viscosity of the elutriating fluid in poises
and: conditions are such that streamlined flow exists.

The methods fall into two general classifications: those using a liquid sedimentation technique and those employing an air elutriation system. In order to choose which of these two general techniques might fulfill the needs expressed before, our company's Research Department has investigated two methods typical of the liquid sedimentation technique (a modification of the Oden sedimentation balance and a modification of the Andreason pipette), while our routine analytical laboratories employed the Roller analysis which represents the air elutriation procedure. Specific difficulties were encountered in the sedimentation work as follows:

1) Certain wetted catalysts developed a viscous character which, in the case of the Oden balance, caused adherence to the top of the plummet, regardless of its shape or location in the suspension. No adequate solution for this difficulty could be found.

2) For use in the Andreason pipette, it was found extremely difficult to select a sedimenting medium which would satisfactorily balance high dis-

PART I of this series, which reports an analysis method of ascertaining the size distribution of a catalyst, appeared in the June issue of Petroleum Refiner. This method was developed specifically to serve requirements of a catalyst manufacturer and in the opinion of that company's staff is the best method it has seen to date. The staff hopes that this report will be so recognized by the industry and that general adaptation of this method of particle size analysis will result. Part III will appear in an early issue.

persing power with the low volatility required for complete evaporation from the small samples withdrawn.

3) Catalyst particles exert a powerful tendency to agglomerate. While it was found possible to select a sedimenting medium which would deagglomerate a particular catalyst, no liquid was found which was adequate for all the catalysts which have to be tested. The testing of a new catalyst therefore required an intensive search for a satisfactory deagglomeration-sedimentation medium. And data indicated that even when an apparently satisfactory medium had been found, agglomeration did occur sporadically and in a completely unpredictable, inconsistent manner.

4) Motion of the plummet in the Oden balance, currents caused by withdrawal of pipetted samples and the existence of concentration gradients all tend to disturb the dynamic equilibrium which is the basic assumption of these methods.

5) The calculation of results from sedimentation data requires the construction of tangents to a curve. It was found that this operation was considerably dependent on personal preference, so that separate individuals could get different final results from the same data. The effect is even greater between separate laboratories.

Need for Precision Accuracy

For these reasons, it was decided that the liquid sedimentation methods are subject to fundamental faults for which no adequate solution was apparent, and that these weaknesses resulted in the sacrifice of both the accuracy and precision desired. Attention was therefore directed toward the air elutriation technique practiced as the Roller test, realizing that here, too, weaknesses existed as explained below. However, the work of Matheson[5] led us to believe that the Roller apparatus could be worked into a test procedure possessing both precision and accuracy.

The Roller apparatus and procedure[2, 3, 4] are sufficiently familiar that repetitive description is not necessary in this paper. However, to approach the design of a new test, it is first essential that the faults of the basic procedure be known in detail. In the Roller method, the basic weaknesses were found as follows:

1) Very poor precision: The data in Table 5 present statistical evidence of the precision of the two ramifications of the Roller test practiced in our analytical laboratories. It is apparent that although the precision of the finer fractions is acceptable, precision in the coarser range is intolerably poor. Data made available to us from the laboratories of other companies have convinced us that this poor precision is inherent in the method and not peculiar to our organization.

TABLE 5

Precision of the Roller Analysis

Test Conditions:		
Jet Diameter: Inches	0.071	0.082
Air Rate: L./Min.	9.6	10.6
Air Humidity: Percent Relative	29	29
Deter. of End Point	0.10% min. breakdown	Time

Statistics on Roller Fractions:

Type of Catalyst	Ground B-6	Ground F-1	Ground C-2
0-20 Microns:			
N=Number of Tests	49	92	60
$\bar{X}$=Arith. Avg. Level	20.36	21.24	11.41
σ=Std. Deviation	1.04	0.70	0.63
2σ=95% Tolerance Limits	±2.07	±1.39	±1.26
20-40 Microns:			
N	49	92	60
$\bar{X}$	22.0	24.36	16.82
σ	1.20	0.85	0.87
2σ	±2.78	±1.71	±1.75
40-80 Microns:			
N	49	92	60
$\bar{X}$	29.5	41.70	39.82
σ	2.70	2.02	2.28
2σ	±7.20	±5.84	±4.56
80 Microns:			
N	49	92	60
$\bar{X}$	28.1	12.62	31.96
σ	3.82	2.74	2.70
2σ	±7.65	±5.47	±5.41

2) Poor accuracy: If, at this point, the corresponding screen data are used as a consistent base for judging level or magnitude, it can be demonstrated that the Roller test is completely inconsistent in this respect. Seldom, and only by coincidence, do the screen and Roller data plot as one continuous curve. In the great majority of cases, the Roller analysis will indicate a greater or less percentage of coarse material present than the corresponding screen analysis, depending upon whether the catalyst is a hard, non-attritable, dense, used catalyst or whether it is a relatively soft, attritable, less dense, fresh catalyst. This is indicated by the typical data in Table 6. Thus we have two tests which do not agree on the amount of material present at the 80 micron level, and furthermore this difference is extremely variable due to the assignable causes of attrition, hardness and density.

3) Presence of attrition: The Roller test is designated as a particle size distribution analysis. Yet in order to deagglomerate and lift the material from the sample holder, a jet of air is used the velocity of which is 246 feet per second. While this might be quite satisfactory when testing the non-friable type materials for which the test was originally designed, such a high jet velocity constitutes an effective grinder when introduced into the more readily attritable material typical of most catalysts. Therefore, when used in catalyst analysis, the Roller method actually constitutes a combined particle size-attrition test contrary to its defined aim. Moreover, since material is continually removed from the sphere of attritive action as a function of particle diameter and therefore time, the coarser the particle the more severe is the attrition to which it is subject. This is to say, an attrition gradient exists with time of testing and the particle size distribution undergoes continual alteration as the test progresses. And finally, it was found that the degree of attrition is sensitive to the exact placement of the jet in the "U" tube and the tension on the hammer spring, and that these two variables are difficult if not impossible to control.

4) Effect of electrostatic charge: The accumulation of an electrostatic charge by some catalysts has already been mentioned. In the Roller analysis, this results in agglomeration of particles and adherence to the walls of the elutriation cylinders. During periods of low relative humidity weather, the material weight recovery after testing was found to be low even though each cylinder was hammered at the conclusion of its use to loosen adhered particles. After an interval of several hours, hammering would bring down much of this adherent catalyst as a cloud. Efforts to neutralize the electrostatic forces by grounding the

TABLE 6

Accuracy of the Roller Analysis

Effect of Type of Catalyst Under Test

TYPE OF CATALYST	Ground F-1	Ground C-2	Microspheres	Used Ground
Screen Analysis: Weight Percent:				
On 40 U.S. = 420 Microns	0.0	0.0	0.0	0.0
100 = 149	0.9	4.0	1.6	0.2
140 = 105	8.0	26.3	8.1	1.8
200 = 74	20.4	49.6	25.9	10.3
Roller Analysis: Weight Percent:				
0-20 Microns	21.8	11.8	12.8	9.3
20-40	21.9	14.8	26.2	29.1
40-80	43.2	38.2	45.5	46.5
80+	13.1	35.2	15.5	15.1
Ratio: On 200 Mesh (74+ Microns) / Roller 80+ Microns	1.56	1.41	1.67	0.68

TABLE 7

Effect of Air Humidification on Analysis by Air Elutriation

CATALYST B-6, NO PRETREATMENT

Relative Humidity of Air	29		60	
Statistics	$\bar{X}$	2σ	$\bar{X}$	2σ
0-20 Micron fraction	20.4	±2.05	20.3	±1.22
20-40 Micron fraction	22.0	±2.77	21.6	±0.66
40-80 Micron fraction	29.5	±7.39	30.3	±4.42
80+ Micron fraction	28.1	±7.65	27.8	±4.53
Number of Analyses	49	49	10	10

CATALYST B-6, PREHEATED 3 HOURS AT 1000 °F.

Relative Humidity of Air	29		60	
Statistics	$\bar{X}$	2σ	$\bar{X}$	2σ
0-20 Micron fraction	12.8	±8.71	18.3	±1.49
20-40 Micron fraction	23.7	±6.75	21.4	±1.24
40-80 Micron fraction	32.5	±8.15	29.2	±6.17
80+ Micron fraction	31.0	±7.60	31.1	±5.79
Number of Analyses	36	36	12	12

$\bar{X}$ = Level by the arithmetic average.
2σ = Two times the standard deviation = limits at 96 percent tolerance limits.

cylinder, and subjecting the sample to ultraviolet light all proved fruitless.

Matheson's Modifications

The modifications of the Roller analysis proposed by Matheson[9] have been used as a basis for the elimination of the effects of attrition, agglomeration and electrostatic adherence. Matheson's modifications include the substitution of a porous bronze plate in a one-inch i.d. metal aeration tube for the standard "U" tube, jet, and "U" tube hammers, and the use of 50-70 percent relative humidity air in place of the standard 29 percent relative humidity air specified in the method.

For the development work in our laboratory, it was decided to use glass for the sample holder and fritted plate so that the action of fluidization could be visually observed. For this purpose, special aeration tubes were made for us to meet the following specifications: a 1-inch i.d. tube containing a porous glass plate extending wall-to-wall 2 inches below the top of the tube, the 1-inch tube being drawn down to a 7 mm. diameter tubulation 1 inch below the porous plate so that an air inlet tube can be readily attached, and the porous plate fulfilling the glass works' requirements for coarse porosity which is a nominal 40 micron opening. The particular porosity was selected on two bases, the ability to support the entire sample without holding the very small diameter particles within its pores, and low pressure drop which during operation has been found to average about 20 mm. of mercury. This aeration tube is fastened directly to the bottom of the Roller cylinder with a rubber tube connection so that the glass is nearly in contact with the metal. Visual observation of the fluidized sample reveals that aeration takes place uniformly across the entire tube and that sample motion is entirely in an up-and-down direction without violent turbulence.

Data presented later in this report indicate that attrition is practically eliminated by the use of the fritted disc. Furthermore, microscopic examination of the 80+ micron fraction has revealed that very few agglomerates exist, so that it may be concluded that the fluidization occurring in the sample tube effectively reduces agglomeration to a minimum.

Humidification of the air used in the particle size analysis has been standardized at 60 percent relative humidity. This is controlled by bubbling the air through 38.40 percent H_2SO_4 (32.86° Be′) prior to introduction to the apparatus. The effectiveness of the humidified air is indicated by the weight balances obtained from quadruplicate analyses on the 12 catalysts later referred to in Table 11. These data show that the weight recovery has increased from the range of 97 percent normally found in Roller analyses to 100.08 percent. Of course, the weight increase is an impossibility, but since it represents only about 0.007 grams of sample, it is considered to be within the probable errors in the measurements. The data confirm that humidification effectively eliminates the retention of catalyst in the cylinders by electrostatic attraction. The data in Table 7, show the effect of air humidification upon both the precision and level of the measurements. Using a standard catalyst, a multiplicity of analyses were made using air of 29 and 60 percent relative humidity on heat pretreated and unpretreated samples. In all cases precision was appreciably improved, with the greatest improvement occurring in the precision of the finer fractions of the thermally pretreated samples. This is probably the result of improved weight recovery and the reduction of electrostatic charge. The only change in level occurred in the 0-20 micron fraction of the pretreated samples.

Investigation of Sample

Inasmuch as sample humidification improved the screen test and humidified air improved air elutriation, the effect of humidification of the sample to be elutriated was investigated. The data are included as Table 8. In all cases the effect of sample humidification was to slightly decrease the 0-20 micron end of the distribution curve and increase the 80 micron end. However, since the effect of the more severe steam humidification was found to be less than that of 60 percent relative humidity air (i. e. A minus B is consistently greater than A minus C which is contrary to the severity of humidification), it must be concluded that the differences noticed between the degrees of humidification represent random fluctuations within the limits of error of the test, and therefore that pretest sample humidification is of no benefit. This conclusion was verified by mathe-

TABLE 8

Effect of Sample Humidification on Analysis by Air Elutriation

	0-20μ					20-40μ				
SAMPLE No.	A	B	C	A-B	A-C	A	B	C	A-B	A-C
Ground B-1	13.6	10.8	12.2	2.8	1.4	16.9	16.3	17.0	0.6	—0.1
Ground B-2	....	13.6	14.5	....	....	....	18.3	19.0	....	....
Ground B-3	15.1	12.7	14.6	2.4	0.5	19.2	18.7	18.6	0.5	0.6
Ground B-4	15.9	13.6	15.6	2.3	0.3	17.9	18.3	18.2	—0.4	—0.3
Ground B-5	13.0	11.4	12.3	1.6	0.7	16.1	16.4	16.7	—0.3	—0.6
Ground B-6	18.6	18.0	18.6	0.6	0.0	21.3	20.7	21.3	0.5	—0.1
Algebraic Avg. Difference	....	....	....	1.94	0.6	....	....	....	0.18	—0.10

	40-80μ					80+μ				
Sample No.	A	B	C	A-B	A-C	A	B	C	A-B	A-C
Ground B-1	32.5	31.1	33.0	1.4	—0.5	37.0	41.9	37.8	—3.9	—0.8
Ground B-2	....	25.9	34.6	....	....	....	32.4	32.0	....	....
Ground B-3	35.9	37.8	35.4	—1.9	0.5	29.8	30.9	31.4	—1.1	—1.6
Ground B-4	35.7	36.3	34.8	—0.6	0.9	30.5	32.0	31.5	—1.5	—1.0
Ground B-5	32.2	31.8	30.5	0.4	1.7	38.7	40.5	40.5	—2.8	—1.8
Ground B-6	34.5	35.6	34.6	—1.2	0.1	25.7	26.7	25.6	0.0	0.1
Algebraic Avg. Difference	....	....	....	—0.78	0.54	....	....	....	—1.86	—1.02

A = No pre-test humidification.
B = Prehumidified with 60 percent relative humidity air for 2 hours
C = Prehumidified with steam at 1 atm. for 21 hours.
All separations made using fritted disc and air humidified with 60 percent relative humidity air, analyzed in duplicate.

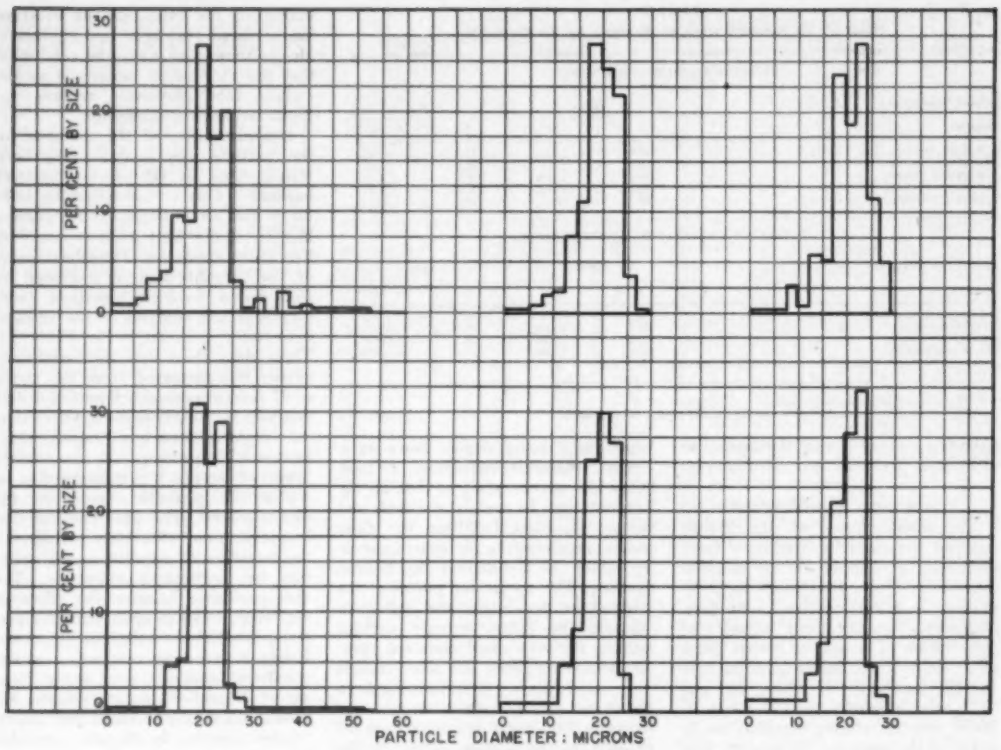


Figure 3. Particle Size Distributions 0-20 Micron Fractions.

matical testing of the data. The differences were found to be statistically insignificant.

While the use of a fritted disc and 60 percent relative humidity air has been thus proved to eliminate the detrimental effects of attrition and agglomeration and to considerably improve precision, these means fail to offer a solution to the most perplexing of all problems, namely the effect of differences in the densities of the catalysts to be tested. In order to better understand the nature of this problem, Stokes Law can be arranged into the form:

$$D^2 = \frac{18\,V\,\mu}{g\,(\rho s - \rho)}$$

Since a practical laboratory test dictates a fixed system, μ, V, g, and ρ in this equation are constant. Thus the relationship becomes approximately:

$$D = \frac{K}{\sqrt{\rho s}}$$

where the error from ignoring the "ρ" term is <0.1 percent. This is to say that the diameter is inversely proportional to the square root of the particle density. It is then apparent that unless some adjustment be made, the measured diameter of a particle via the fixed Roller test must vary as a function of density, and furthermore that the only particle truly measured will be the one whose density happens by pure coincidence to be the one for which the fixed air rate of 9.6 liters per minute applies. To repeat, the Roller analysis with fixed air rate can be accurate only for material of one specific density level.

Complicated Problem

The problem is further involved by the fact that the determination of the density applicable to Stokes Law and the Roller analysis is extremely complicated. First, it is obvious that the Stokes Law density is a buoyancy factor, and that therefore the density must be a function of everything contained within the surface envelope of the particle: the material constituents, the pore volume, the exact fluid filling the pores, and any liquids or vapors adsorbed on the pore surface. Knowing all of these values, the "effective density" can be calculated. However, the amount of water vapor adsorbed on the surface of the catalyst during elutriation is not known and cannot be known until the analysis is completed. Data presented later illustrate that this can represent an increase in weight of from one to eight percent when using 60 percent relative humidity air, depending upon the nature of the catalyst under test. We are thus faced with the dilemma of having to consider the effect of a variable whose magnitude is unknown until the test is completed. Were this not so, a correlation of air rate against "effective density" would suffice. A technique has been developed which permits the determination of what is called the "elutriation density," this density being a function of the effective density of the particles under the elutriation test conditions.

With these problems in mind, it was decided that the best approach would be first to establish the correct air rate for a catalyst of fixed density; and second, using this air rate, attempt to correlate the change in measured particle diameter as the effective particle density is varied from this fixed value. For this first step, the perfectly microspherical catalyst previously used in the screening studies was em-

TABLE 9

Summary of Microscopic Examination
Microspherical Catalyst

	0-20 MICRON FRACTION				20-40 MICRON FRACTION			
	Percent By Size		Percent By Weight		Percent By Size		Percent By Weight	
PARTICLE DIAMETER: μ	8 L/M	9 L/M	8 L/M	9 L/M	8 L/M	9 L/M	8 L/M	9 L/M
Less than 20	41.3	39.3	25.1	24.0	....	....	....	....
Less than 25	98.0	96.3	88.4	83.1	....	....	....	....
Greater than 20	58.7	60.7	74.9	76.0	....	....	....	....
Less than 30	....	....	....	....	0.0	0.0	0.0	0.0
20-40	....	....	....	....	99.7	95.0	99.1	90.5
Greater than 40	....	....	....	....	0.3	5.0	0.9	9.5
	40-80 MICRON FRACTION				80+ MICRON FRACTION			
Less than 40	15.3	3.3	5.1	0.6	....	....	....	....
40-80	80.4	85.0	80.3	64.5	....	....	....	....
Greater than 80	4.3	11.7	14.6	34.7	....	....	....	....
Less than 80	....	....	....	....	17.3	4.7	3.4	0.7
Greater than 80	....	....	....	....	82.7	95.3	96.6	99.3

ployed so that the particle shape factor would be eliminated and because screen and microscopic examination were already available.

In determining this correct air rate, the problem of setting a standard for accuracy again arises. It would be desirable to continue on the basis of the microscope count, and it will be observed later that the correlation technique hereinafter developed would apply equally to the microscopic count standard. However, there is a practical consideration which cannot be ignored. The previous data on screening have indicated considerable discrepancy between the microscope count and the screen test in the region of 80 microns. If, then, an elutriation test be made to agree with the microscopically determined distribution, the present condition of having two tests in disagreement at the 80 micron level will be continued. In the past, this has led to much confustion in the utilizing of particle size data. Accordingly, it is felt that a practical advantage lies in designing an elutriation test which yields a distribution curve continuous with the corresponding screen curve even though a consistent bias is thus introduced. It is emphasized that this decision is entirely arbitrary and not a product of the elutriation technique itself. It is justified solely on the basis of maintaining consistency between the several tests used in particle size analysis. At such time as the aforementioned unfavorable characteristics of the sieves used in screening are corrected, the elutriation test can also be made consistent with the microscope count data. However, this lack of agreement between the screen analysis and the microscope count should not be overemphasized, since it will be shown later that the method of correlation employed tends to minimize the difference.

A series of elutriations were made using duplicate samples of this microspherical catalyst and varying the air rate from 8 to 9.6 liters per minute, so that the coarse end of the resultant curves would encompass the fine end of the screen curve. These data are shown in Figure 2. The cuts from the 8 and 9 liter per minute separations were then submitted to the microscopist for determination of separation efficiency. The microscopic data are summarized in Table 9, and the complete microscopic analyses converted to a weight basis are also shown on Figure 1 (Part I, June issue). The data in Table 9 indicate that on a size basis, the 9-liter-per-minute air rate provides the more efficient separation. But on a weight basis this is not true, the advantage then lying with the 8-liter rate primarily because of oversized material found in the 40-80 micron fraction. However, there are two reasons for using the size distribution as the criterion of separation efficiency:

1) Both elutriation and screen analyses measure diameter, not weight, since the particle density is constant. The instrument should be judged on the basis of the job it is designed to perform.

2) Because the weight varies as the cube of the diameter, small errors in the microscope particle count are greatly magnified in the large particle range. Thus, in examining by microscope a small cut such as the 40-80 micron fraction, the inclusion of a single 81 micron particle is the weight equivalent of about nine 39 micron particles, although the probability of microscopic count error is the same at each end of the fraction. The same is true of off-sized particles actually contained as a result of machine inefficiency.

As a result of microscopic examination, a 9-liter-per-minute air rate was accepted as the basic rate for the separation of a catalyst of the specific density of these microspheres. The data in Table 9 also provide indication that the 4½ inch cylinder makes its best cut at about 24 microns, not at 20 microns as expected. Four other independent microscopic counts on four different 0-20 micron fractions confirm this finding. These data are presented in the form of histograms as Figure 3. The fact that the 20-40 micron fractions in two of the six cases contained no particle below 24 microns, and in three cases no particles below 21.6 microns, lends strong supporting evidence to the statement that the 4½ inch cylinder removes a 0-24 micron cut.

End of Part II. Part III will appear in an early issue.

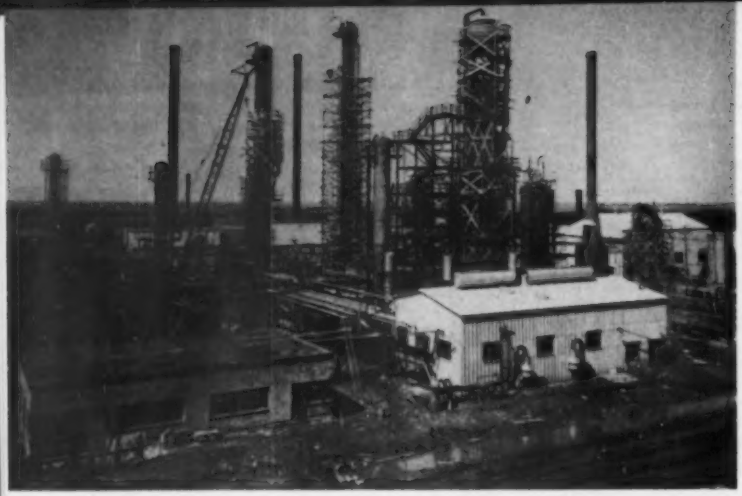
TABLE 10

Rate of Moisture Adsorption
Elutriation with 60% R.H. Air

	TOTAL VOLATILE: WEIGHT PERCENT			
Sample Identification	0-20 Micron Fraction	20-40 Micron Fraction	40-80 Micron Fraction	80+ Micron Fraction
Ground B-1	21.42	21.44	22.43	23.92
Ground B-2	22.30	22.40	22.20	22.90
Ground B-3	20.36	20.95	20.96	22.04
Ground B-4	20.52	21.99	22.28	22.96
Ground B-5	21.74	22.29	21.97	22.96
Ground B-6	19.88	20.73	21.15	22.07
Average	21.04	21.63	21.83	22.81

REFERENCE

[9] Matheson, George L., "Modification in the Roller Analysis for the Determination of Particle Size Distribution," presented at the 27th Annual Meeting of the American Petroleum Institute, Nov. 16, 1947.



General View of B-A's Edmonton Refinery during Construction which Took Less than 13 Months.

Refinery Is Advanced Example Of Combination Oil Processing

THE British-American Company last month officially opened its 5200-barrel combination processing plant on Highway 16 near Edmonton, Alberta. Facilities include crude topping, delayed coking, catalytic and thermal cracking, and gas recovery treating for white products. Extensive service units were included in the building program.

In 1949 Edmonton was selected as the general area for a refinery which was to be a completely integrated unit, incorporating both thermal and catalytic cracking processes. Canadian Kellogg Company undertook the design, procurement and erection of the complete unit early in 1950, and by May, field construction was underway.

Because Alberta has abundant supplies of coal and natural gas, the delayed coking process was specifically included in the over-all arrangement since it enables the plant to produce a minimum of bunker fuels for which Alberta has little or no demand.

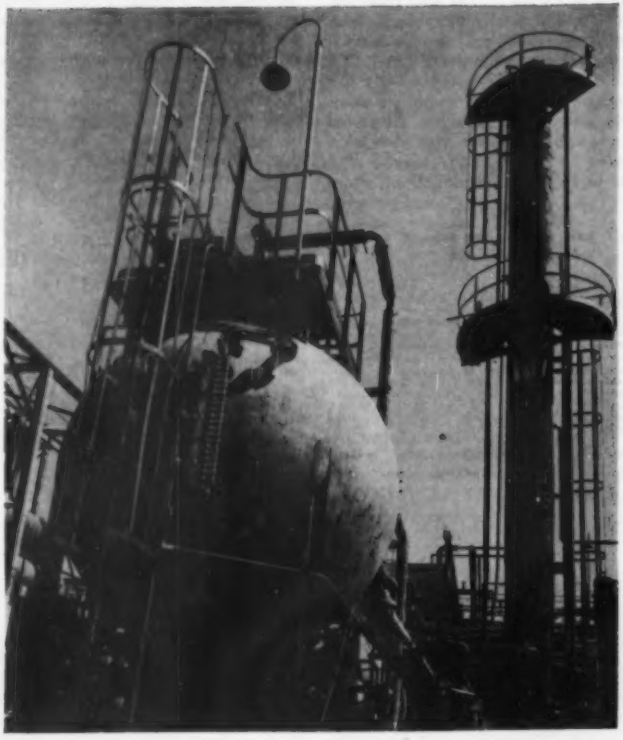
According to the plant's designers, B-A's new refinery is probably the world's most advanced example of combination oil processing. Embodied in the plant is Alberta's first catalytic cracking unit, which makes possible the production of high-octane gasolines. This is the second catalytic cracking unit to be erected by the company. The first operates at the B-A Montreal East Refinery and is Canada's largest.

High-voltage electricity is delivered by the local power company to the edge of the refinery. Many miles of cable and several sub-stations were required to perfect the electrical system.

Steam is manufactured by boilers capable of producing 120,000 pounds of steam per hour. Installed with the boilers is a complete feed-water treating system and other necessary facilities.

Water is taken from the North Saskatchewan River. Two intake lines were run into the river for a distance of 300 feet and anchored to the river bed by means of concrete. The water flows through these intake lines to the deep-well pumphouse on shore.

Supplies of crude oil fed to the plant by pipe line from the nearby fields of Alberta, Saskatchewan, and British Columbia have eliminated need for volume crude storage, although the refinery is provided with 460,000-barrel-tankage capacity for use in processing and storing finished products.



Desalter and Stabilizer at B-A's Edmonton Refinery.

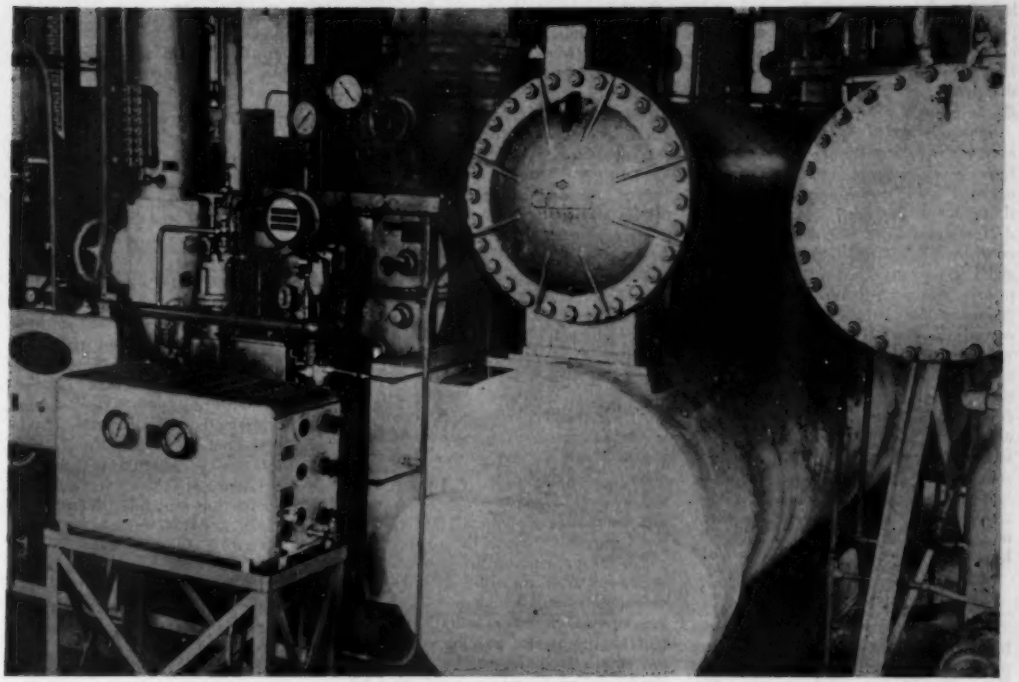


Figure 1. Centrifugal refrigeration compressor used for cooling process chilled water in a synthetic rubber plant. Instruments used for compressor operation appear at left. (Courtesy of Carrier Corporation.)

REFRIGERATION

In the Refining Industry

PART III

TYLER G. HICKS
Mechanical Engineer, New York

THE FIRST two articles in this series briefly discussed various applications of refrigeration in the refining, natural gasoline, and petrochemical industries. Those articles showed that there are few process plants in operation today which do not use at least one refrigerating compressor in production or air conditioning operations. This article, the last of the series, discusses various phases of refrigeration system operation in process plants. Operating practices considered are those which have been found to cause most difficulties in various plants. Hence, they should be of interest to operators and designers alike.

RECIPROCATING compressors for refining processes must often serve low temperature production units. Operating difficulties sometimes arise because low-temperature operation introduces problems which must be solved by both designer and operator. The best way to show how suction pressure variation affects reciprocating compressor operation is to take a look at typical performance figures.

With normal condenser pressure and a standard ammonia reciprocating compressor, capacity obtained with a 175-psi. condenser pressure and various suction pressures is as follows:

Suction Pressure, psi.	−5	0	10	20	30	40
Capacity, tons	0.26	0.41	0.70	1.0	1.31	1.61

A study of these values shows that the lower the suction pressure the smaller the tonnage obtained. For instance, a compressor rated at 150 tons when suction pressure is 20 psi. and condenser pressure 175 psi. will have a capacity of only 150 (0.41) = 61.5 tons at a suction pressure of 0 psi. There are several causes for this reduction in capacity but the principal one results from the properties of the refrigerant.

The density of the saturated refrigerant decreases with pressure. Since at any load reciprocating units have fixed piston displacement, the weight of refrigerant discharged decreases as suction pressure does. Tonnage produced is a function of the amount of heat removed in the condenser. With

less heat being removed, system capacity is reduced. The above example illustrates one such typical case. Hence, the importance of operating at the proper suction pressure can readily be seen.

The operator fixes the suction pressure by regulation of compressor suction valve setting, expansion valve opening, and compressor speed. Although not too well recognized, the designer also has some control over compressor suction pressure. Undersized pipes, excessively long runs, or poorly designed bends will increase friction losses between evaporator and compressor. As a result, compressor will operate at a lower suction pressure, reducing system capacity. Suction lines should therefore be designed for the minimum pressure loss obtainable. Conservative practice limits this loss to somewhere between 1 and 4 psi. per 100 feet of pipe, including bends. Total equivalent length of suction line should not exceed 100 feet; if at all possible, it should be much less.

High Suction Pressures

The above discussion would seem to indicate that the higher the suction pressure, the better the operation. However, this is not always true. Excessively high suction pressures may overload compressor driving motor or engine, causing trouble in the prime mover. Hence, although designers should make every effort to keep friction losses low, operators should try to keep suction pressure at the value recommended by the manufacturer.

Prime mover overloading results from the fact that the discharge or condenser pressure rises with the suction pressure. System capacity increases and horsepower input per ton decreases. However, the over-all effect of increased capacity is a rise in the total input required for compressor drive. Unless cooling water flow to the condenser can be increased, or condenser heat transfer surface increased, discharge pressure of the compressor cannot be reduced. Since increase of condenser cooling-water flow or heat transfer area is generally not possible, power input will increase. Operators should strive to maintain proper suction pressure at all times, if they wish to avoid overloading of prime mover or reduction of system capacity.

Too high a discharge pressure will decrease reciprocating compressor plant efficiency also. As head pressure increases, so does the power input increase. System capacity decreases too, further reducing the efficiency of the system.

Excessive head pressures may result from small discharge lines, too small a condenser, hot cooling water, insufficient quantity of cooling water, air and inert gases trapped in the condenser, dirty or scaled heat transfer surfaces, or over-charge of the refrigerant. As can be seen, these causes can be traced to either poor design or operating methods.

Low pressure losses in compressor discharge piping, in the range of 1 to 3 psi. will prevent overloading the compressor. Piping sized for pressure losses in this range will seldom, if ever, cause trouble. Initial cost of the installation will be greater because larger diameter pipe will be necessary. However, daily operating costs will be less and the resulting savings will quickly pay off the extra investment for the larger pipe. A reduction of 25 psi. in head pressure will decrease compressor power costs by about 12.5 percent.

Too small a condenser and hot cooling water may also be a result of design economics. Since the capacity of a condenser cannot be conveniently increased after installation, it is wise to choose a unit which has a slightly greater capacity than actually needed. Hot cooling water can be caused by too small a condenser, by an undersized cooling tower or pond, and by insufficient pumping capacity for the cooling system. Since all these factors are under the control of the designer it is good practice to provide 10 to 20 percent extra capacity when specifying units. Initial cost will be somewhat higher but the additional dependability and flexibility of the plant make it well worthwhile.

Operating Pressures

As a guide to typical suction and discharge pressures encountered in certain refining operations, the following tabulation is helpful. It also permits comparison of the volumes of gas which must be handled to produce one ton of refrigeration.

	NH_3	Propane	Isobutane	Butane	F-11
Suction Pressure, psia.	66	72	25	16	6.3
Discharge Pressure, psia.	186	183	80	41	18
Cfm of Refrigerant, per ton	1.8	2.35	5.85	8.0	17.0

As can be seen from this table, the hydrocarbon refrigerants operate at lower pressures than ammonia but the volume handled by the compressor per ton of refrigeration produced is greater. Low-pressure refrigerants generally do not require use of pipe heavier than schedule 40 and receivers and valves can be of correspondingly lighter weight. This is one of the many reasons they have found such wide application in refining, natural gasoline, and petrochemical applications.

Besides compressor suction and discharge pressures there are several other factors which reduce system capacity. In general, these are operating problems and must be handled as such. A few of the more common causes of reduction in system capacity are detailed here.

Accumulated frost on the exterior of evaporator coils, carryover of lubricating oil to the interior of these coils; leaky valves, piston rings, or scored cylinder walls; clogged suction valves or pipes; insufficient refrigerant charge and water in the evaporator coils will all reduce system capacity. The only way any of these troubles can be spotted before they affect system capacity is by use of a rigid inspection schedule. Reduced capacity can seriously hamper production activities or may even require shutdown while refrigeration units are repaired. The importance of continuous supervision of refrigerating equipment is therefore readily apparent.

Reciprocating Compressor Care

Compressor racing is a common fault. Since all types of prime movers are used for compressor drive in refineries, racing of a compressor may be caused by driver or compressor faults. With gas or Diesel engines, racing may be caused by a faulty governor. In the compressor, improper valve operation will cause racing. Stuck suction valves unload the piston, permitting the compressor to race. If the discharge valve sticks, the compressor will pound noisily and operate unevenly.

The best method of shutting down ammonia and similar compressors is by the following procedure: 1) Shut off liquid valve; 2) pump evaporator and liquid line down to zero gauge pressure (14.7 psia.); 3) shut off condenser cooling water; 4) stop compressor; 5) close discharge valve at condenser; 6) close compressor suction valve; 7) open bypass valve between suction and discharge line; gas will now flow from discharge to suction side; 8) close compressor discharge valve. Leave bypass open to prevent system pressure from rising above the suction pressure.

The best lubricant for ammonia compressors is a paraffin oil. High flash-point and viscosity, together with a low congealing point are desirable.

Refrigerating capacity of these units

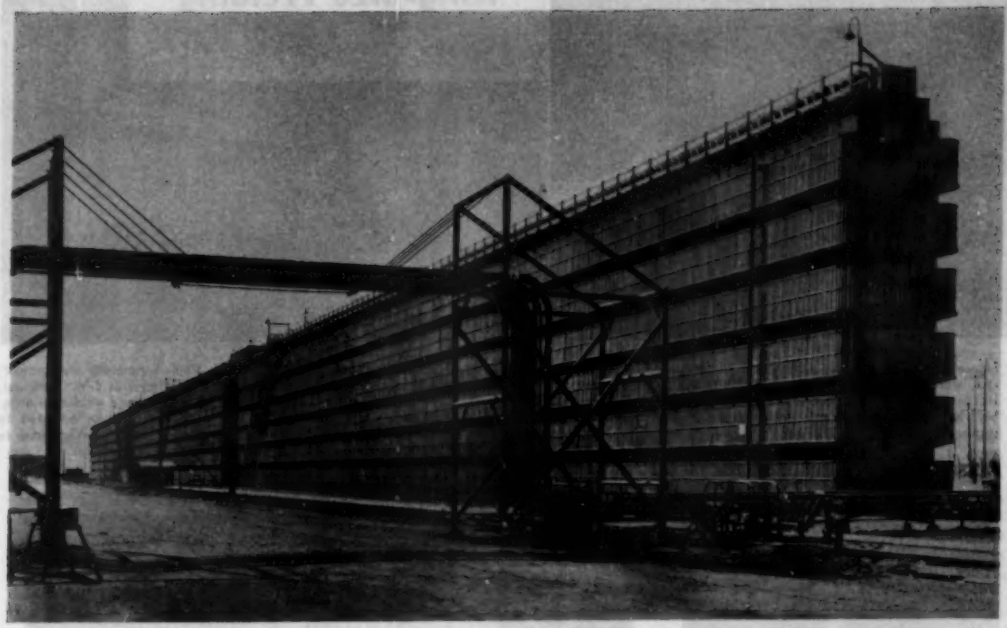


Figure 2. Large cooling tower similar to units used for reducing condensing water temperature. Effective heat removal prevents excessive head pressures and reduces refrigerating machine operating costs. (Courtesy of The Fluor Corporation.)

is controlled by any one of the following methods: (a) variation of compressor speed, (b) use of a throttling damper to regulate vapor flow from cooler to compressor, (c) variation of condenser cooling water flow to raise or lower compressor discharge pressure. The operator has direct control of the compressor through these means and varies capacity to suit load. These controls have the following characteristics.

Variation of compressor speed is considered most desirable because only a small change in speed is necessary for a large change in load. Speed regulation is suitable for both constant and widely varying loads. Power input is low and directly proportional to the load. Compressor speed variation is the most economical method of capacity control.

When a turbine drives the compressor, turbine speed is varied to change compressor speed. Slip ring motors with multiple-step resistance are used for electric drives. Constant speed motors can be fitted with hydraulic couplings or with an eddy current clutch for variable speed drive of the compressor.

Constant speed compressors use suction damper control. The damper throttles vapor flow, handling low density vapor through a larger pressure differential when system load is reduced. Compressor handles the same volume of vapor as at normal load. Power requirement per ton when this type control is used is greater than with speed control.

Condenser cooling water control is also used for constant speed machines because system capacity decreases as condensing pressure increases. In areas where cooling water is scarce, and hence expensive, load control by variation of cooling water flow is most economical. Power required is greater than with speed control. Condenser cooling water control is often used in conjunction with step speed control.

All large centrifugal compressors are fitted with at least four safety devices, each of which either reduces turbine speed or stops the driving motor during emergencies. Safety devices with which plant operators and designers must be familiar are 1) low oil pressure cut-out, 2) high condenser pressure cut-out, 3) low evaporator temperature cut-out, 4) low chilled water temperature cut-out.

These controls stop the compressor when lubricating oil pressure falls below normal and when condensing water flow stops for any reason. Failure of the chilled water circulation system or reduction to too low a temperature will also cause compressor to stop automatically. Thus, it can be seen that the modern centrifugal compressor is a fully protected unit.

Non-condensible gases and air which collect on the high side of a refrigerating system increase head pressure and power input required to operate the compressor. Hence these gases must be removed periodically to prevent excessive power bills. In small systems, hand operated purge valves are fitted to the condensers at points where gases are most likely to accumulate. Centrifugal compressors are fitted with a separate purge compressor which operates continuously. It is a small reciprocating compressor which discharges non-condensibles to an air cooled condenser where refrigerant is removed. Designers can insure maximum efficiency by providing purge devices on the high sides of all systems. Operators can get most from a system by using the purge whenever head pressure increases above normal.

Conclusion

This series of articles has discussed briefly the various applications of refrigeration in the refining industry. As the articles have indicated, a knowledge of refrigeration is necessary for all plant designers and operators. This brief survey should serve as a basis for further study on the part of the designers and operators.

End of Part III and series.

King-Size Welding

Figure 1. Fabricating 5½-inch plate into pressure vessels, condensers, etc., which must withstand up to 70,000 psi. is no small job. Flat sections (shown at left) are heated, then formed in this press, sections here being 3½ inches thick. Foster Wheeler Corporation has handled sections as thick as 5½ inches. Workmen is setting up flame-cutting tractor used to bevel sections for welding.

Figure 2. Sections are roll-formed, tack welded manually (foreground) and then seam welded by the submerged-arc process at F-W's Cartaret, N. J., plant. On heavier sections, the first pass is hand welded in a jig. This submerged-arc automatic welding machine can be adjusted to accommodate sections of considerable diameter and can be used to make both exterior and interior welds.

Figure 3. Neat, uniform appearance of weld bead is typical. Weld is on the interior of a section.

Figure 4. This view was especially posed to show the comparative depth (3½ inches) of the joint to be welded. In his left hand the operator holds the switch which controls electric-motor-driven rollers which rotate the section as the operator progresses.

Figure 5. After the head has been manually welded in place, this General Electric automatic welding machine finish-welds the circumferential seam by multi-layer metal-arc process. The section is turned at steady rate to provide even layers.

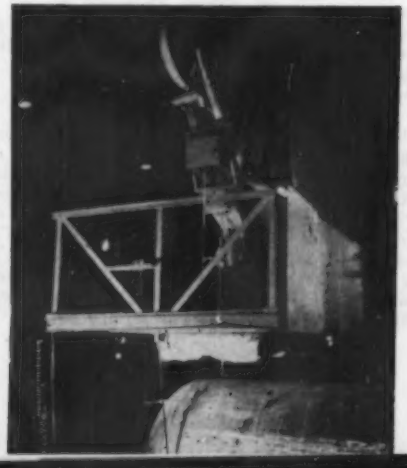
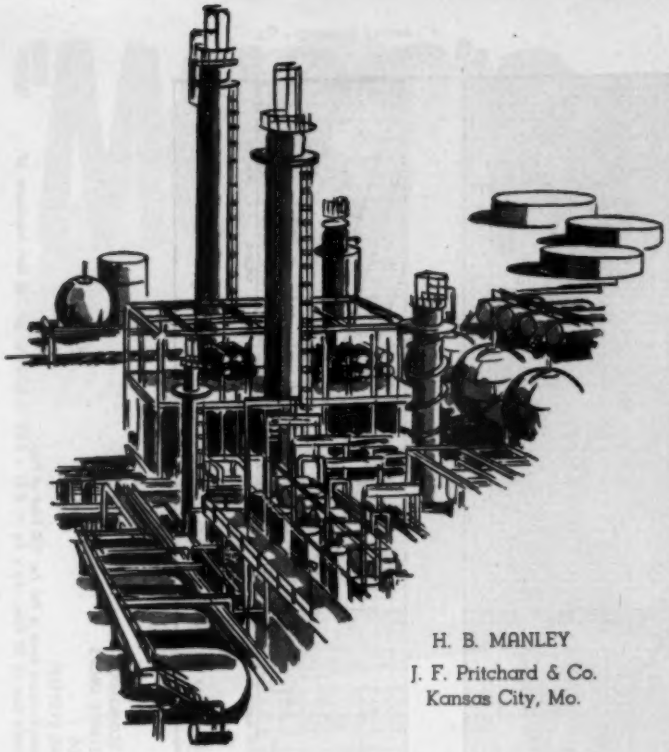


Figure 6. Fillet welds joining the nozzles to the head of this pressure vessel show the quality of welding. G-E welding machines, located out of the way along shop walls, furnish power for this and other finish welding as well as for tack welding.



H. B. MANLEY
J. F. Pritchard & Co.
Kansas City, Mo.

Economic Line Sizing For Plant Piping

MODERN processing plants may be considered as a group of separate flow systems, interconnected and operating as a unit. The pressure drops due to friction in the pipe lines of these flow systems must be predetermined and the lines correctly sized in order to develop the design capacity of the processing equipment with reasonably balanced piping and power costs. Consideration of each flow system with regard to its part in the process, control characteristics, flexibility and economics, is necessary in order to correctly size the pipe lines and establish pump heads and characteristics.

The chart, Figure 1, has been developed for use in establishing line pressure drops that are reasonably within the average plant economic range. Power cost of pumping is a function of pounds per hour pumped and line pressure drop. Piping cost depends on line size which for compressible gas or steam is largely a function of pounds per hour and absolute pressure. Other factors used in determining actual power cost and line cost may be averaged and for the purpose of this chart *line pressure drop plotted against absolute pressure*. The optimum pressure drops indicated on the chart correspond to line sizes in the range of good economic practice.

IN VIEW OF the large number of variables and the small amount of data which is available on this subject, it is believed this article will be of considerable value to Petroleum Refiner readers.

The chart showing economic pipe line pressure drops for plant piping systems as designed by Mr. Manley appears on the next page. It is being so positioned so that those readers who care to, may tear out the single sheet for filing.

The Fp (pressure factor) on the chart is in units of pounds per square inch per 100 feet of line and indicate the maximum practical pressure drop for process and utility lines up through six-inch pipe size. For lines eight-inch size and over pumping cost becomes a significant factor and the Fg (quantity factor) should be applied. Fg is designed to correct for power cost of approximately $30 per horsepower per year and on the basis of average current costs of steel pipe, valves and fittings in place.

Referring to the chart it will be noted that the pipe lines have been segregated into groups dependent on their function in the plant. Short steam leads to equipment such as pumps or turbines are generally controlled flows and have a high cost of valves as compared to mains. A higher pressure drop within the limits of measurement and control flexibility has therefore been used for these lines. For large quantities the Fg factor should be applied.

The Fp value for liquid pump discharge lines is independent of the absolute pressure except as cost of line increases at higher pressures. It is therefore indicated as a constant for pressures up to approximately 300 psia. and follows the steam lead to equipment line for higher pressures. The Fg factor should be applied for large quantities.

The routing and sizing of pump suction lines are an important part of plant piping. For design purposes the Fp values indicated on the chart are intended to balance to some extent the cost of various sizes of pumps and cost of elevating suction tanks containing boiling liquids. For large quantities the Fg factor should be applied.

Gathering systems and gas transmission lines are generally designed for specific power and line costs. The values shown on the chart should be used for preliminary design only.

The optimum line pressure drops will usually fall between two standard line sizes. It is suggested that the chart, Figure 1, be used in conjunction with charts which plot various line sizes against pounds per hour (with correction for density) and pressure drop per 100 feet of line. In the choice of a slightly smaller line with higher pressure drop as compared to a much larger line with less than optimum pressure drop other factors of actual power cost, control flexibility, etc., should influence the selection. In the case of steam lines, the optimum pressure drops indicated on the chart may be used and line sizes plotted against quantities for various pressures. For liquid lines the optimum pressure drops indicated may be transposed to feet of flowing liquid and established tables used for line size selection.

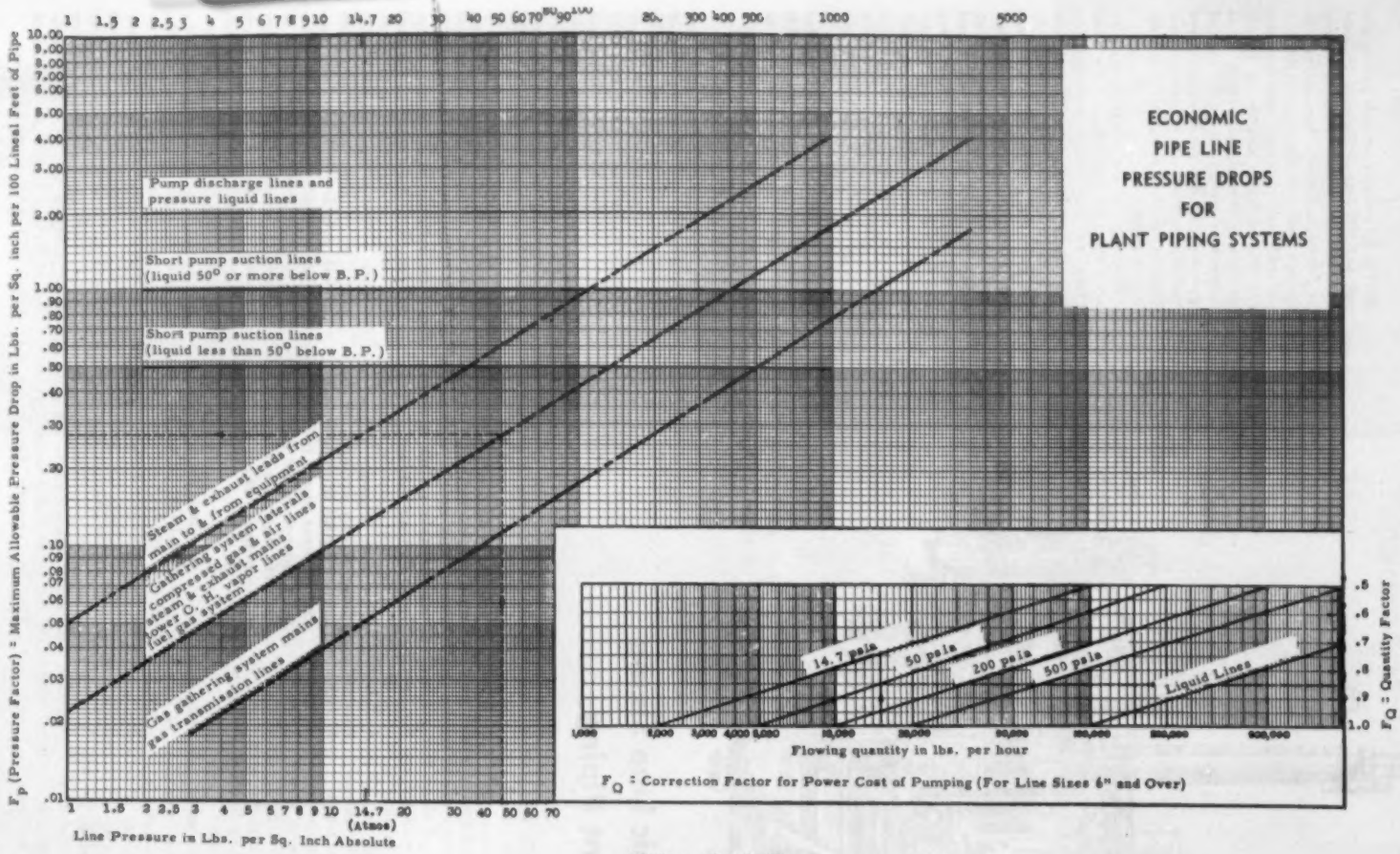
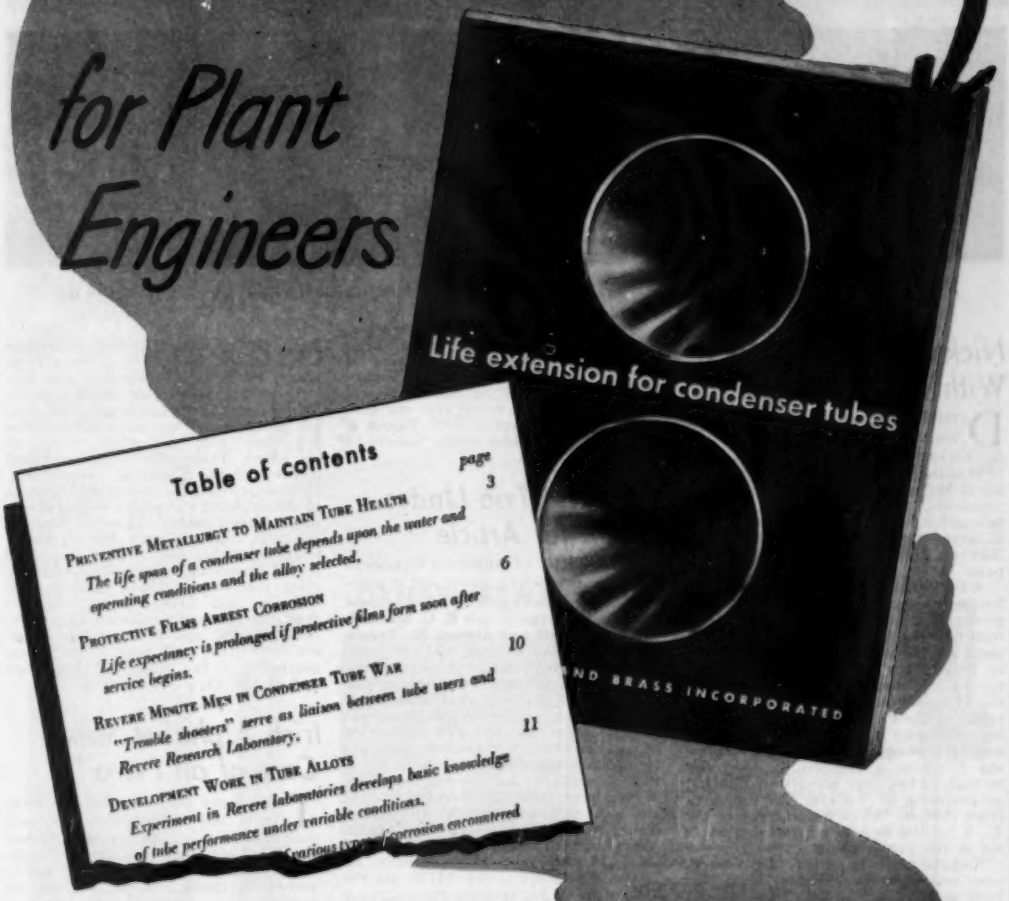

ECONOMIC
PIPE LINE
PRESSURE DROPS
FOR
PLANT PIPING SYSTEMS
Pump discharge lines and pressure liquid lines
Short pump suction lines (liquid 50° or more below B. P.)
Short pump suction lines (liquid less than 50° below B. P.)
Steam & exhaust leads from main to & from equipment
Gathering system laterals
compressed gas & air lines
steam, O, & exhaust mains
lower H, vapor lines
fuel gas system
Gas gathering system mains
gas transmission lines
14.7 psia
50 psia
200 psia
500 psia
Liquid Lines
Flowing quantity in lbs. per hour
Fp (Pressure Factor) = Maximum Allowable Pressure Drop in Lbs. per Sq. inch per 100 Lineal Feet of Pipe
Line Pressure in Lbs. per Sq. Inch Absolute
(Atmos)
FQ = Quantity Factor
FQ = Correction Factor for Power Cost of Pumping (For Line Sizes 6" and Over)

FIGURE 1. ECONOMIC PIPE LINE PRESSURE DROPS FOR PLANT PIPING SYSTEMS.

To Use: Multiply Fp x Fq to Find Maximum Economic Pressure Drop in Psi. Per 100 Feet of Pipe.
Example: Given—15,000 Pounds per Hour Compressed Gas @ 50 Psia.—Fp x Fq = 0.27 x 0.85 = 0.23 Psi. per 100 feet Maximum ΔP.

"MUST" Reading

for Plant Engineers


Life extension for condenser tubes
Table of contents
page
PREVENTIVE METALLURGY TO MAINTAIN TUBE HEALTH
The life span of a condenser tube depends upon the water and operating conditions and the alloy selected. 3
PROTECTIVE FILMS ARREST CORROSION
Life expectancy is prolonged if protective films form soon after service begins. 6
REVERE MINUTE MEN IN CONDENSER TUBE WAR
"Trouble shooters" serve as liaison between tube users and Revere Research Laboratory. 10
DEVELOPMENT WORK IN TUBE ALLOYS
Experiment in Revere laboratories develops basic knowledge of tube performance under variable conditions. 11
various types of corrosion encountered
ND BRASS INCORPORATED

• We doubt very much if you have ever read a booklet on Condenser Tubes, quite like this one.

Plant engineers should find it of unusual interest particularly with present restrictions on copper and its alloys making it more important than ever that every last ounce of use be squeezed out of the condenser tubes in their plants.

This 28-page booklet includes data on various copper alloys, photos of cut-away tube sections showing various types of corrosion encountered in condenser tube service and photomicrographs showing the grain structure of different kinds of metals under varying operating conditions.

Send for your copy today. Please make request on your firm's letterhead. Thank you. Address Department P.R., Revere Copper and Brass Incorporated, 230 Park Avenue, N. Y. 17, N. Y.

REVERE 150 YEARS SERVING THE AMERICAS

COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.—Sales Offices in Principal Cities, Distributors Everywhere.

SEE "MEET THE PRESS" ON NBC TELEVISION EVERY SUNDAY

REFINER AUTHORS and Other Personalities

Information, formal and otherwise, about the men who write for PETROLEUM REFINER as well as others prominent in the industry.

A. L. Nickerson

F. Taylor, Jr.

E. C. Medcalf

Gerard N. Vriens

A. Garrett Hill

Nickerson Revisits PR With Text of Speech

DOMESTIC marketing director for Socony-Vacuum Oil Company, A. L. Nickerson, who was the October, 1950 author of "No Time Now for Political Manipulations and Socialistic Experiments," returns to PETROLEUM REFINER's authors' circle with a condensation of a recent speech, "The Middle of the Barrel Comes of Age," found on page 71.

A 1933 graduate of Harvard, he joined Socony's marketing division on the ground floor as a service station salesman to preface a rapid climb to appointment as New England division manager in 1941. Later that year he took temporary leave of absence to serve with the War Manpower Commission as director of the Placement Bureau. Returning to Socony in 1943, he was appointed general manager of the Eastern Marketing Division, a position he soon left to make a two-year sojourn in England as chairman of Vacuum Oil Company from 1944-46. When he returned to the U. S. in 1946 he was appointed a director of the parent company.

Nickerson is a native "Up-Easter" who was born in Dedham, Mass. He lives in Rye, N. Y., with his wife and their four children.

Taylor Discusses Gas Analyzer Advance

FIELDING TAYLOR, JR., author of "New Thermocouple-Type Combustible Gas Analyzer Expands Field of Application" on page 124, is general manager of Davis Instruments, division of Davis Emergency Equipment Company, Inc., Newark, N. J. A 1937 graduate of Worcester Polytechnic Institute, Mass., with an M.E. degree, he was employed one year at Buffalo Forge Company, and then left for New York City to join American Machine & Metals, Inc., as engineer. By 1941 he had been offered, and accepted the position of manager of Davis Emergency Equipment Company, Ltd., in San Francisco. He was promoted to general manager of the Newark plant in 1945. Taylor is a member of the Instrument Society of America.

Chemical Trio Unites Talent for Article

THE TRIO of American Cyanamid chemists who collaborated in writing "Aromatics Recovery by Solvent Refining" on page 97, are **E. C. Medcalf, A. Garrett Hill,** and **Gerard N. Vriens.**

Chief chemist for the coal tar products and acids departments of the Chemical Department, as well as vice chairman of the technical committee, Vice chairman of the ASTM committee phases of development and production of coal tar products, inorganic acids, intermediates and rubber chemicals. A native of Indiana, he received an M.A. degree from Indiana University in 1932 and went on to employment with American Cyanamid as a research chemist. Vice chairman of the ASTM committee on D-16, Aromatic Hydrocarbons, he is also a member of the AICE and the ACS. One of his favorite relaxations is playing duplicate bridge, and he evidently relaxes with skill for he was a member of the bridge team which won the Eastern States Industrial and Commercial Team of Four championship in 1950 and 1951.

Vriens, another duplicate bridge devotee, has been engaged with process development work in the Chemicals Department since 1949. He graduated from Purdue University with a Ph.D. just prior to joining American Cyanamid. A native of New York city, he served two years active sea duty as a Naval Reserve during World War II; he is a member of the ACS and a junior member of the AICE. His favorite summertime recreation is a fast game of tennis.

Largely contented with his small farm in the Jersey hills, **Hill** finds little time and even less inclination to stray from home, but friends sometimes lure him forth for a game of golf. Another of his hobbies is color photography. It may be he associates the quiet country life in Jersey with the silent sweep of his native Texas plains. As technical director of the Chemicals Department, he is responsible for the technical phases of development and production of chemicals, rubber, rubber chemicals, coal tar products, intermediates for dyestuffs, pharmaceuticals and explosives. Hill joined American Cyanamid immediately after receiving a Ph.D. degree from Yale in 1932. Civic-minded, Hill currently serves as chairman of a Civil Defense Council and a Red Cross Disaster committee, and until recently was president of the Board of Education and of the Civic Association.

Irish Alphabet Stew— Case of an Extra "e"

TOO many cooks spoiled the stew, Irish, last month when we were guilty of tossing an extra "e" into the grand old name of Kelly. So, to the readers whom we have confused and to author Raymond C. Kelly, we offer our apologies for misspelling his name in connection with his article, "U.S. Industrial Strength May Depend Upon Water Supply," while spelling it correctly in the index and authors' pages.

Our regrets, too, to lovely Mrs. Kelly who was overlooked in the Kelly sketch which mentioned the Kelly daughters as comprising the remaining "household."

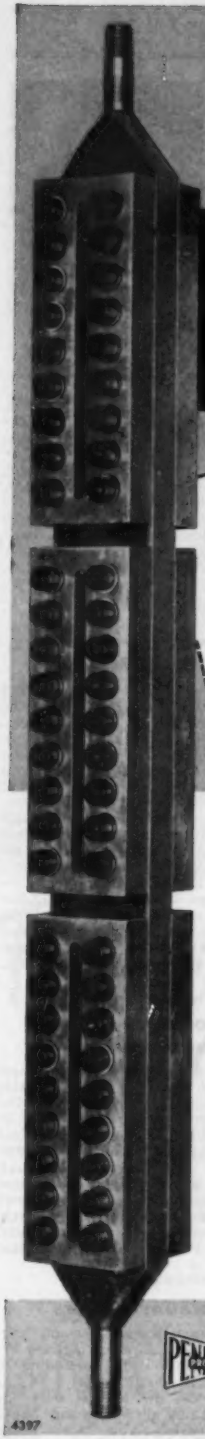
Manley Offers Tip on Economical Line Sizing

H. B. Manley, native Missourian, and author of "Economic Line Sizing for Plant Piping," found on page

for operating pressures up to

10,000 psi

PENBERTHY transparent LIQUID LEVEL GAGES



Another PENBERTHY First

Patent Applied for

These gages were developed by Penberthy in answer to persistent demands from the process industries and various laboratories for a gage with UNOBSTRUCTED VISIBILITY at service pressure ratings up to 10,000 psi. They are tested to 15,000 psi. Temperature rating is 250° F dry gas . . . 300° F wet gas.

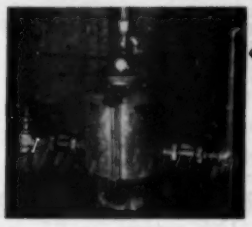
In addition to their value as liquid level indicators, these gages are useful at reaction chambers, equilibrium cells, high pressure manometers, etc.

The standard gage body containing the liquid chamber is forged carbon steel but stainless steels are available. Design is such that glass is entirely relieved of bolting pressure . . . providing a better seal and avoiding those stress concentrations which cause so much glass breakage.

These Penberthy 10,000 psi gages are of proven dependability . . . they have been in field service for more than two years. Write us regarding your requirements.

OTHER PENBERTHY PRODUCTS

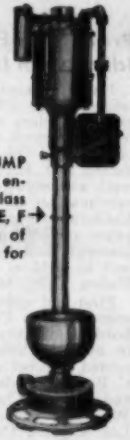
PENBERTHY REFLEX GAGE. Empty space shows white, liquid shows black. You can't misread. Available in special alloys and now available for operating pressures up to 5,000 psi. Ask for Catalog 35.



PENBERTHY CYCLING JET PUMPS. Automatically operated by air, gas or steam pressure . . . Will pump without clogging any liquid that will flow through pipes. Ask for Bulletin 5030.

PENBERTHY EXPLOSION-PROOF SUMP PUMPS. Motor and switch totally enclosed. Underwriter approved for Class 1, Group D, and Class 2, Groups E, F and G hazardous location. Made of copper and bronze throughout. Ask for Bulletin 4929.

PENBERTHY EJECTORS. A simple jet pump operated by air, water or steam. Needs no lubrication . . . will not get out of order. Ask for Bulletin 5080.



PENBERTHY ALSO MANUFACTURES A COMPLETE LINE OF LIQUID LEVEL GAGES IN BRONZE, IRON, STEEL AND ALLOYS

PENBERTHY INJECTOR COMPANY

DIVISION OF THE BUFFALO-ECLIPSE CORPORATION

DETROIT 2, MICHIGAN

Established 1886 — *Canadian Plant, Windsor, Ontario*

4397

H. E. Manley | J. G. Allen | D. M. Little | P. M. Waddill | Abraham I. Gartner

151, earned his engineering degree at Missouri University. A project engineer for J. F. Pritchard & Company in Kansas City, Mo., he has seen extensive service during the past 20 years while working for various oil companies and contractors. During that time he has gained experience in refinery and gas plant engineering as well as many friends in the industry. At the time his last article was printed in the PETROLEUM REFINER he was employed as a senior mechanical engineer for Stanolind at Tulsa.

The Manleys' 12-year-old son, David, who will be in the seventh grade next term, has been in and out of so many schools due to his father's transfers, that he probably never found time between Yonkers, N. Y., Boston, Mass., Tulsa, Okla., Powell, Wyo., or Kansas City, Mo., to decide whether or not he shares the usual schoolboy apathy toward that institution.

Manley likes to fish, play golf, dabble a bit with carpentry, enjoy a concentrated game of bridge.

Professors Exchange Ideas with Industry

Eight professors who represent a specific scientific field will meet, work and exchange ideas with scientists of California Research Corporation, subsidiary of Standard Oil Company of California, during 1951. Each professor will spend a week with industrial research men, in the continuation of a program started by California Research Corporation several years ago. Meetings between industrial scientists and the educational scientists will be held at the Richmond and La Habra, Calif., laboratories.

First 1951 visitor at the Richmond laboratories was Professor Glenn T. Seabord, University of California, expert in nuclear chemistry. Seven more expected to visit are: Professor Herbert C. Brown, Purdue University, Inorganic and Organic Chemistry; Professor Saul Winstein, University of California at Los Angeles, Organic Chemistry; Professor Donald L. Katz, University of Michigan, Chemical Engineering; Professor Victor H. LaMer, Columbia University, Physical Chemistry; Professor Carl C. Monrad, Carnegie Institute of Technology, Chemical Engineering; Professor Morris S. Kharasch, University of Chicago, Organic Chemistry; Professor Robley C. Williams, University of California, Bio-physics Electron Microscopy.

Perco Chemists Write Of Visbreaking Research

THE THREE Perco authors of "Visbreaking of a High Vacuum Petroleum Residuum" on page 107, by coincidence all joined the Phillips organization as chemists at the Phillips, Texas, refinery.

P. M. Waddill received his B. S. degree in chemical engineering from Oklahoma A. & M. in 1931 and subsequently was employed as a chemist at the Amarillo, Texas, Helium plant run by the Bureau of Mines, and served with the Texoma Natural Gas Company before joining Phillips in 1934. Until 1943 when he was transferred to Bartlesville as chief of the liaison section of the chemical engineering department, he was engaged in laboratory, process and mechanical engineering and operational supervision at Phillips, and Okmulgee, Okla. Waddill is currently technnical consultant and assistant to the manager of the Refining Department.

J. G. Allen, chief process engineer of the Refining Department at Bartlesville, received his B.S. in chemistry in 1933 from the University of Tulsa and joined Phillips in 1933 to engage in laboratory, process engineering design and development at Phillips, Kansas City, Kans., and Bartlesville. During the war he spent a year in New York working principally with the AGAC Alkylation Committee. In 1945, Allen was a member of the Technical Oil Mission to Germany under P.A.W.

D. M. Little received his B.S. in chemical engineering in 1942 from the University of Nebraska. Currently a senior process engineer of the Refining Department at Bartlesville, his Phillips' experience included laboratory, process engineering, economics, process coordination and development at the Phillips, and Bartlesville plants.

London Sojourner Offers Nomograms As Solution

ABRAHAM I. GARTNER, author of "Nomograms for the Solution of Anchor Bolt Problems," on Page 101, is at present stationed in London as structural consulting engineer for the Foster Wheeler companies in England and France. He has been associated with Foster Wheeler since 1942 and was in charge of the Structural Design Group before his present assignment abroad. Gartner received his B. A. degree at City College, New York, in 1927 and two years later received his degree in Civil Engineering.

Gartner is said to be an expert in chess and photography and enjoys both as hobbies, but his greatest enthusiasm is reserved for his wife and two sons, about whom he is ever ready to speak with pride.

Well-Known Journalist Appointed NAM Manager

Robert L. Humphrey, appointed southwestern regional manager of the National Association of Manufacturers, will make his headquarters in Houston and will "provide and schedule programs and activities to maintain and expand relations between business management and other segments of the public."

The southwestern region, now a part of NAM's Southern division, is directed by W. R. Archer, vice president for the region.

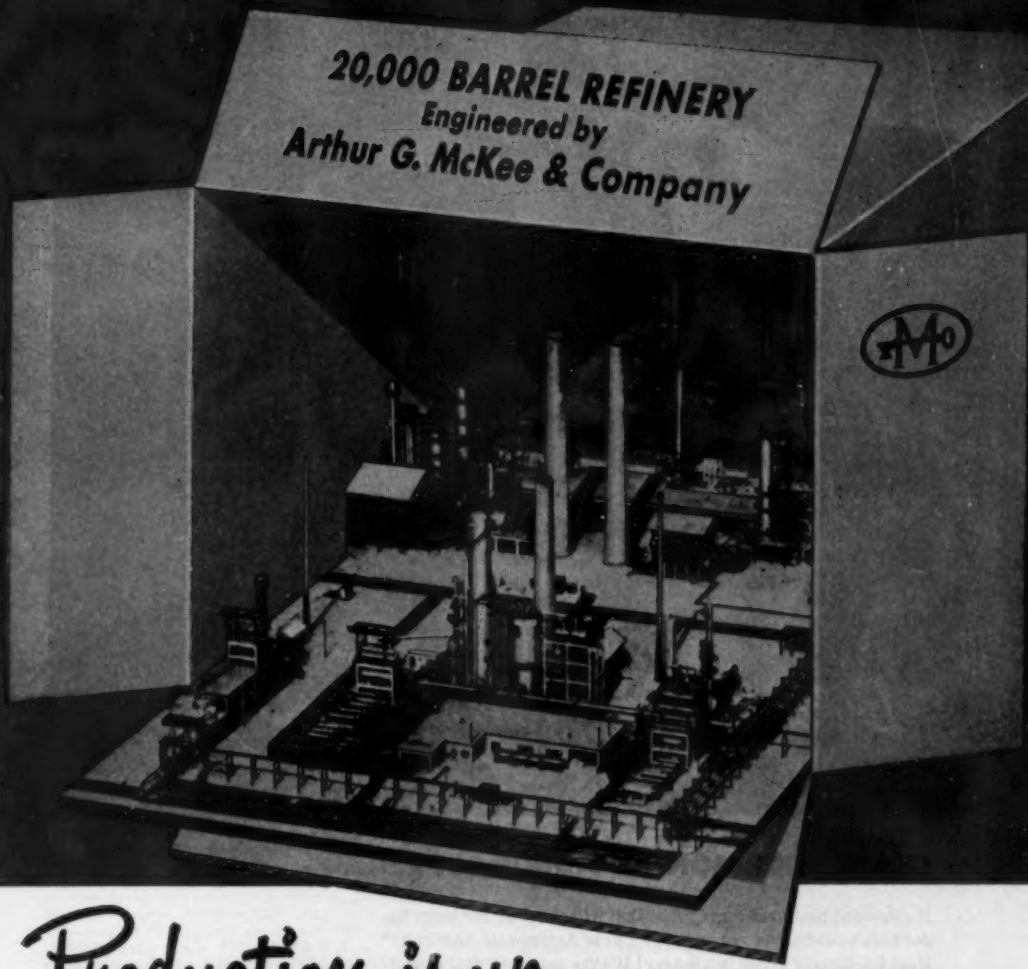
Humphrey attended Oklahoma University and was on staffs of The Dallas Morning News, The Fort Worth Press and The Houston Chronicle. He was recently elected vice president and general manager of Associated Publishers, Inc., Dallas.

Dr. Cole Coolidge Named Du Pont Chemicals Head

Appointed director of the chemical department of Du Pont Company this month, Dr. Cole Coolidge succeeds Dr. Elmer K. Bolton who retired June 30. Dr. Bolton, director for 21 years, had been assisted by Dr. Coolidge since 1939. Dr. Coolidge will direct the research activities of the chemical department which are primarily concerned with long-range and fundamental research. A graduate of Ohio State University, he joined Du Pont shortly after graduation in 1923.

Esso Petroleum Officers

Leonard Sinclair was elected chairman and managing director of Esso Petroleum Company, Ltd., succeeding R. A. Carder, who died recently. W. E. Jenkins and N. F. Myers were appointed managing directors and M. C. Tett a director.



Production is up

ON NEW "TOOLS" FOR PETROLEUM REFINING

McKEE is engineering and constructing complete refineries, individual processing units and other refining facilities in many locations. The Refinery Division of this organization will continue to devote every effort toward keeping pace with the Refining Industry's expansion program.

DESIGN, ENGINEERING AND CONSTRUCTION FOR THE PETROLEUM REFINING AND IRON AND STEEL INDUSTRIES

McKee Engineering

Arthur G. McKee & Company • Established 1905

Headquarters: McKee Building, 2300 Chester Avenue, Cleveland 1, Ohio. *New York:* 30 Rockefeller Plaza, New York 20, N.Y. *Tulsa:* 918 First National Bank Building, Tulsa 3, Okla. *England:* The Iron and Steel Division of Arthur G. McKee & Company, is represented by Head, Wrightson & Co., Ltd.

CHASE ANTIMONIAL ADMIRALTY *(A patented alloy)*

If you want heat exchanger tubes that will stand up for years under tough conditions, remember... Chase Antimonial Admiralty* Heat Exchanger Tubes last longer! It's the antimony that does it!

These great heat exchanger tubes have enough antimony to resist dezincification. And antimony will not weaken the tube. The metal starts with the right grain structure and retains it... it stays tough and withstands the stresses of heavy duty assignments.

You'll do better with Chase Antimonial Admiralty Heat Exchanger Tubes! Send coupon for FREE Book.

*U.S. Pat. No. 2,061,921

CHASE WAREHOUSE STOCKS:
NEW YORK, BALTIMORE,
NEW ORLEANS, LOS ANGELES
Also carried by
Vinson Supply Co., Tulsa,
Standard Brass & Mfg. Co., Houston.

FREE CHASE BOOK discusses corrosion problems and selection of proper alloy for condenser and heat exchanger tubes.

Chase Brass & Copper Co., Dept. PR 751
Waterbury 20, Conn.
Please send me your free book on Condenser and Heat Exchanger Tubes.

Name_____
Firm_____
Position_____
Address_____
City_____ State_____

Chase **BRASS & COPPER**

WATERBURY 20, CONNECTICUT • SUBSIDIARY OF KENNECOTT COPPER CORPORATION

• The Nation's Headquarters for Brass & Copper

Albany†	Cincinnati	Houston†	Minneapolis	Pittsburgh	Seattle
Atlanta	Cleveland	Indianapolis	Newark	Providence	Waterbury
Baltimore	Dallas	Kansas City, Mo.	New Orleans	Rochester†	
Boston	Denver†	Los Angeles	New York	St. Louis	(†sales office only)
Chicago	Detroit	Milwaukee	Philadelphia	San Francisco	

The MONTH... in the INDUSTRY

Venezuela to Sponsor September Oil Convention

Caracas will be the site of Venezuela's first National Petroleum Convention announced for Sept. 9-18. Sponsored by the government, the convention purpose is to acquaint the world with the Venezuelan oil industry and oil problems. Oil men, equipment manufacturers and engineers, service company technicians and representatives of government and private technical societies from other countries will be invited.

Staff members of the Technical Office of Hydrocarbons will preside over general sessions and sectional meetings will be led by representatives of oil companies operating in Venezuela. Dr. Gustavo Thery Fombona, director, Technical Office of Hydrocarbons, Ministry of Mines and Hydrocarbons, Caracas, is in charge of arrangements.

Safety smiles pop out when California plant gains award. (See item below picture.)

GET SAFETY AWARD—The safety performance record of 2,234,124 hours of work without a disabling injury won the employes of The General Petroleum plant at Vernon, the Socony-Vacuum award. G. L. Adams (left), General Petroleum vice president, presents the safety award to J. H. Tipps, chairman of the foremen's safety committee. J. H. Curtis (center), manager of manufacturing, looks on. In presenting the award, Adams said, "Records such as this come only from operational know-how and constant vigilance. Safety is everybody's job."

St. Hilaire Returns U. S.

Frank D. St. Hilaire who recently resigned as refinery and terminal superintendent for Barber Oil Corporation, Trinidad, B. W. I., is now connected with Graver Construction Company as resident superintendent in the East Chicago-Indiana harbor area. Last year, St. Hilaire was in Saudi Arabia building "Tapline" as project engineer for Graver.

Plans for Oil Industry Standardization Approved; Murphree New Chairman

Dr. E. V. Murphree, president of Standard Oil Development Company, was elected chairman of the permanent council of the Third World Petroleum Congress during the recent sessions of that organization at The Hague. Speaking before the Congress, Dr. Murphree reported that the performance of gasoline produced in the U.S. in 1950 was 67 percent more powerful than gasoline produced in 1925, based on knock-free performance records. During the same period, he said, the bulk cost at the refinery dropped from 12 to 10½ cents a gallon.

"The 1950 refinery cost compares with 20 cents that would have been paid in 1925 for gasoline giving the same effective energy as one gallon of present day gasoline," Murphree declared in pointing out progress achieved by the industry.

Research activities, largely responsible for that progress, have increased in cost from $1.5 million in 1925 to nearly $100 million during the past year. Murphree said that the greatest advances in crude oil production had resulted from study of underground reservoirs, a search which has led to a 25 percent additional recovery in recent years, he said.

Plans for standardization in almost every field of oil production and research were confirmed at the final plenary session of the Congress, and included the following points which were agreed upon by experts from 42 countries:

A clearer and more appropriate terminology on underground movement of oil "because of existing and threatening confusion.

Investigation into possibility of clarifying various terms used within the oil industry for describing different reserve classes.

A co-ordinating committee for Western Europe, including the United Kingdom, for the use and standardization of oil equipment to establish uniform international standards.

An international petroleum vocabulary sponsored by the international organization for standardization.

International exchange of fundamental data on all hydrocarbons.

Standard procedures for testing casing centralizers, and standard specifications for joint casing.

Standardized notations for physical quantities and mathematical functions used in the oil industry.

Standardization of definitions and analysis of organic matter.

It was further agreed to organize more exchanges of information and collaboration between the production manipulating, and user oil industries on construction materials. Individual research and work must be continued, but would provide for periodic discussions between the groups.

Another resolution urged continued study of the sensitivity, stability and availability of standardization of fuels for use in knock-rating engines, plus measures to inter-correlate existing knock-rating correlation schemes.

G. A. Van Tuyl Schuitemaker, chairman of the organizing committee, said that one of the most noteworthy results of the Congress was the establishment of a single method throughout the world for estimating and registering oil reserves.

The 1955 meeting of the World Congress will be held in Europe, and the succeeding Congress in 1959 probably will be held in the U. S.

Nofsinger Moves Offices

Offices of the C. W. Nofsinger Company were moved to The Rialto Building, 906 Grand Avenue, Kansas City 6, Mo., the first of this month. The Nofsinger Company is a petroleum and chemical engineering and contracting firm.

Alberta Crude Transported To Toronto by Pipe-Tanker

Last month British American Oil Company of Canada inaugurated its program of shipping western Canadian crude oil to its refinery near Toronto, Ontario. First Canadian crude to be transported as far east as Lake Ontario was 25,000 barrels piped from the Leduc field in Alberta to Superior, Wis., and there loaded aboard the British American motor vessel Elmbranch. A half million barrels of Leduc crude is scheduled to be delivered to the eastern refinery this year.

Previously the company supplied its Clarkson plant with U. S. crude oil shipped directly from Toledo, Ohio, but the installation of pipe line facilities between Alberta and the Great Lakes has made it possible for British American to supplement crude requirements with domestic production. The company is building a $4.5 million tanker to augment its fleet, bringing the total number of vessels owned and chartered by the company to 19. The tanker will have a carrying capacity of 115,000 barrels.

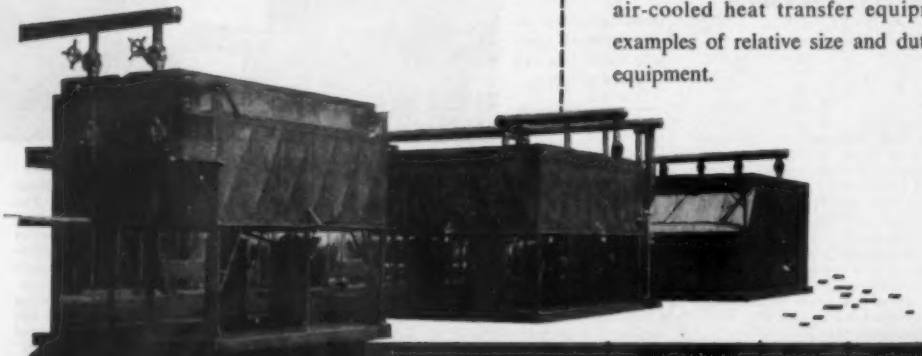
Five Engineering Men Promoted by Phillips

Five Phillips Petroleum Company employees in the Engineering and Research and Development departments were promoted recently. E. F. Kindsvater, former manager of the engineering department, will be transferred to the Washington office to work on procurement and allocation of materials.

George R. Benz, originally employed in the engineering department 26 years ago, becomes manager of that department following the resignation of A. H. Riney who had been head of the engi-

Here are 15 TYPICAL APPLICATIONS for FIN-FAN AIR-COOLED Heat Exchanger Equipment

For many years, Fin-Fan Air-Cooled Heat Exchangers have proved their worth by giving reliable, economical service in many and varied applications. The Fluor Corporation, Ltd., and Griscom-Russell Company, pioneer-partners in the air-cooled heat transfer field, offer the following to show the large variety of practical applications for air-cooled heat transfer equipment and examples of relative size and duty of such equipment.



GAS COOLING	Natural Gas After-Cooler	13,920,000	80	46' x 25'
	Manufactured Gas Cooler	11,165,000	80	23' x 21'
	Natural Gas After-Cooler	3,400,000	15	11' x 21'
	Natural Gas Inter-Cooler	7,890,000	40	23' x 21'
VAPOR CONDENSING	Reflux Condenser	18,407,000	90	48' x 25'
	Primary Condenser	4,652,000	40	11' x 25'
	Still O.H. Condenser	4,875,000	34	16' x 21'
	Debutanizer Condenser	11,930,000	60	23' x 25'
	Still Reflux Condenser	39,110,000	60	46' x 25'
	Steam Condenser	87,300,000	300	138' x 31'
	Steam Condenser	2,880,000	10	10' x 6'
LIQUID COOLING	Vegetable Oil Cooler	628,000	15	6' x 17'
	Absorption Oil Cooler	14,915,000	100	32' x 17'
	Quenching Oil Cooler	1,665,000	50	23' x 25'
	Amine Solution Cooler	19,300,000	175	38' x 25'
	Stabilized Crude Cooler	125,100,000	700	315' x 25'
	Jacket Water	2,400,000	5.5	16' x 12'
	Jacket Water	28,800,000	100	70' x 24'

A new 8-page bulletin on Fluor-GR Fin-Fan Heat Exchangers is now being prepared. Write in and reserve your copy by post card or letter.

Why Fluor-GR Fin-Fans Lead The Field

The Fin-Fan Air-Cooled Heat Exchanger is unique in its development and manufacture. It is the result of the engineering skill of *two* companies, *each* long recognized as leaders in their respective fields. It combines Fluor's experience in the design, fabrication and field erection of air-moving systems with Griscom-Russell's experience in heat transfer.

Success is evident in repeat orders. Since 1941, hundreds of Fluor-GR Air-Cooled Heat Exchangers have been installed throughout the world . . . nearly 50% have been repeat orders!

FLUOR

BE SURE WITH FLUOR

ENGINEERS • CONSTRUCTORS • MANUFACTURERS

THE FLUOR CORPORATION, LTD., 2500 S. Atlantic Blvd., Los Angeles 22, Calif., *Offices in principal cities in the United States*

REPRESENTED IN THE STERLING AREAS BY: Head Wrightson Processes Ltd., Teesdale House, Baltic Street, London, E.C.1., England

neering section for 30 years. C. K. Buell will replace Benz as manager of the chemical engineering division of the research and development department, and will in turn be succeeded as assistant manager of that division by R. C. Cole. R. E. Weis has been promoted to superintendent of Philtex Experiment Station.

Antitrust Irresponsibility Spotlighted by Dismissal

Dismissal of the "Mother Hubbard" case recently, highlighted the original irresponsibility of the antitrust division in filing suits of this tppe according to comments by T. S. Petersen, president of Standard Oil Company of California. The suit was filed more than ten years ago against practically the entire oil industry but was postponed due to national emergency during World War II. Last year the Justice Department filed a virtually identical suit against seven large oil companies on the West Coast, including Standard of California.

When the second suit was brought the West Coast companies involved pointed out the unfairness of being required to defend two huge suits at the same time, involving the same issues, and filed a petition to prevent the government from proceeding further with the West Coast case.

The antitrust division hastily dropped the "Mother Hubbard" case before the Supreme Court could act.

"If the antitrust division were consistent," said Petersen, "it would take the same action in the West Coast suit, which is equally unfounded, and which places the same burden on us that the Attorney General himself says led to the World War II postponement of the 'Mother Hubbard' case."

Oil Compact Extension Slowed by House Criticism

Debate as to the nature, claimed by some representatives to be monopolistic and in restraint of trade, and necessity of the Interstate Oil Compact waged hotly in the House of Representatives the past few weeks, although the Senate voted unanimously to extend the Compact another four years.

Governor Allan Shivers, Compact committee chairman, testified that the Compact has "worked exceedingly well" in facilitating co-operation between member states on problems of conservation and declared that "organized confusion" would result if Congress failed to extend the Compact whose function is to conserve oil and gas resources.

Socony Promotes Veterans

Promotions of B. F. Wingrove and S. W. Thomson of Socony-Vacuum's Paulsboro, N. J., refinery have been announced with Wingrove named operating department superintendent, and Thomson assistant superintendent of the lubricating oil division of the operating department.

Wingrove had eleven-years experience at Beaumont, Texas, with the Magnolia Petroleum Company before being transferred to Paulsboro in 1949. He succeeds R. M. Chesney, appointed new manager of Deep Rock Oil Company's refinery at Cushing, Okla.

Thomson, formerly supervisor of specialties in the package division, has been employed at the Paulsboro plant since 1937.

Heiss to Manage Expanded Refinery at Destrehan

Pan-Am Southern Corporation recently appointed Henry A. Heiss manager of its Destrehan, La., refinery. He joined the Pan-Am Southern organization from Standard Oil Company (Indiana) where he was general foreman of the light oils division, supervising the operation of catalytic cracking units.

Heiss, a graduate of the University of Iowa, will make his home in Destrehan. The position he fills is a new one created to meet the needs of the multimillion dollar expansion and will not affect J. D. Tufts, superintendent, or R. L. Argus and V. G. Relimpio, assistant superintendents.

THE OIL MAN'S CALENDAR

JULY	
9–21	Summer Laboratory Course, "Techniques and Applications of the Electron Microscope." Laboratory of Electron Microscopy, Rockefeller Hall, Cornell University, Ithaca, N. Y.
19–20	WPRA Regional, Wichita, Broadview Hotel.
24	National Petroleum Council, Quarterly Meeting, Washington, D.C.
AUG.	
13–14	LP-Gas Engine Fuel School, Lafayette, Ind., Purdue University.
13–15	SAE, National West Coast Meet, Seattle, Olympic Hotel.
17	WPRA Regional, Alma, Mich., Leonard Refineries, Aud.
SEPT.	
3– 7	American Chemical Society, Annual, N.Y. Hotel Statler. 120th Nat'onal Diamond Jubilee.
5– 8	Oil Industry Information Committee, N.Y., Waldorf-Astoria.
8– 9	Int. Union of Pure & Applied Chemistry, 16th Conference, N.Y., Hotel Statler.
10–13	Int. Congress of Pure & Applied Chemistry, 12th Conference, N. Y., Hotel Statler.
10–14	Instrument Society of America, Sixth National Instrument Conference and Exhibit, Houston, Sam Houston Coliseum.
11–13	International Discussion on Postwar Heat Transfer Development with ASME Administrative Coordinator, London.
12–14	National Petroleum Association, Atlantic City, N. J., Hotel Traymore.
14–15	Int. Union of Pure & Applied Chemistry, 16th Conference, Washington, D.C., Hotel Statler.
16–19	American Institute of Chemical Engineers, Regional Meeting, Rochester, N.Y. Sheraton Hotel.
20–21	WPRA Regional, Casper, Wyo., Hotel Henning.
24–26	ASME, Sixth Petroleum Mechanical Engineering Conference, Tulsa, Mayo Hotel.
25–28	American Society of Mechanical Engineers, Fall, Minneapolis, Minn., Hotel Radisson.
OCT.	
4– 5	California Natural Gasoline Association, 26th Annual, Los Angeles, Ambassador Hotel.
8– 9	Texas Mid-Continent Oil & Gas Association, Annual, Beaumont, Texas, Hotel Beaumont.
8–10	The American Oil Chemists' Society, Fall, Chicago, Edgewater Beach Hotel.
8–12	National Safety Council, 39th National Safety Congress and Exposition, Chicago, Stevens Hotel.
14–20	Oil Progress Week.
15–17	American Gas Association, Annual, St. Louis, Kiel Auditorium.
18–20	National Association of Corrosion Engineers, South Central Region, Corpus Christi, Texas.
22–24	American Standards Assn., Annual, New York, Waldorf-Astoria Hotel.
NOV.	
5– 8	American Petroleum Institute, Annual Convention, Chicago, Stevens Hotel.

The MONTH . . .

Dr. Robertson to Direct Petrochemical Project

Dr. Nat C. Robertson, recently appointed Director of the Petrochemical Research department of the National Research Corporation, will supervise the petrochemical research and development program which is sponsored jointly by Electric Bond and Share Company, United Gas Corporation and National Research Corporation.

Robertson

Dr. Robertson began his career as a member of the Office of Scientific Research and Development and subsequently was employed by Standard Oil Development Company as a research chemist on butadiene production and Fischer-Tropsch chemicals, and by the Chemical Division of Celanese Corporation of America as a group leader at Clarkwood, Texas. He received his A.B. from Emory University and his Ph.D from Princeton University.

Gentry Lee Named General Counsel of Cities Service

Gentry Lee of Tulsa, was appointed general counsel of Cities Service Oil Company (Delaware) last month but will continue to spend a large portion of his time in Tulsa until previous commitments are fulfilled. He is a partner in the law firm of Conner, Winters, Lee and Randolph. Lee formerly was associated with Barnsdall Oil Company, and is currently general counsel and secretary of Bareco Oil Company of which he has been a director since 1939. He has served on the legal committee of Western Petroleum Refiners Association. He received his law degree from the University of Oklahoma.

ASTM Retains Motor Octane Numbers for Motor Gas

Motor octane numbers are to be retained in ASTM specifications of motor gasoline for another year at least, according to W. T. Gunn, committee D-2 chairman, who reported the committee found insufficient favor of Research over Motor to eliminate the latter.

Grade "80-87" aviation gasoline was added to ASTM tentative specifications for avgasoline as well as "108-135." ASTM 157-43 steam emulsion test for lube oils was reverted to tentative status to be revised by Technical Committee C on turbine oils. Specifications for diesel fuels were revised.

API Reports New Production Heights Reached in June

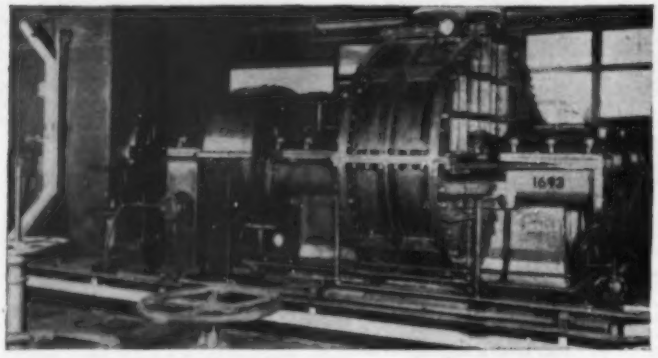
A 212,000-barrel increase in the production of gasoline was noted for U. S. refineries during the week ended June

NEW R·C EXHAUSTER
pays its own way

By replacing a 30-year-old battery of three steam-driven gas exhausters with a new, high-capacity, electrically-driven R-C unit, important advantages were gained, in a large industrial plant:

1. **The one new unit carries the base load.**
2. **Steam needed for 3 other steam-driven exhausters, carrying partial load, is substantially reduced because of slower speeds.**
3. **Heat balance in the plant is maintained.**
4. **Savings in total power cost will pay for the new installation in about one year.**

These very satisfactory results were obtained by careful evaluation of all the factors before deciding upon the type of equipment . . . and then by specifying an R-C Rotary Positive Gas Exhauster that will do the work at low operating cost.



Type RCGH Rotary Positive Gas Exhauster, driven by 450 hp synchronous motor. Capacity, 20,600 cfm.

Even though your equipment to handle gas or air may still have years of life, it may be sound economy to replace it with modern, efficient, R-C units of the right type, size and drives to best meet your needs. Our engineers will help you analyze your problem and make unbiased recommendations of either Rotary Positive or Centrifugal equipment, depending upon your specific conditions. This *dual choice* is an exclusive R-C advantage.

With capacities from 5 cfm to 100,000 cfm, R-C units can be closely matched to work requirements, for dependable, economical performance. At Roots-Connersville, almost a century of blower building experience is at your service, without obligation.

ROOTS-CONNERSVILLE BLOWER CORP.
151 Crescent Avenue, Connersville, Indiana

Type OI Centrifugal Blower in oil refinery operation. Capacity 11,750 cfm.

ROOTS-CONNERSVILLE
ONE OF THE DRESSER INDUSTRIES

The MONTH . . .

23 to set a new all-time high for a second week in succession, according to API statistics. Crude run production during the same period showed an increase of 2600 barrels for a total production of 6,192,050 barrels daily. Runs to stills topped the previous record high set June 2, by 48,000 barrels a day with refinery output of all principal products showing a gain.

Conoco Promotes Hovlid

A. M. Hovlid, Ponca City, Okla., personnel supervisor in Continental Oil Company's Manufacturing department, has been promoted to coordinator of personnel research for the entire company, it was announced last month by John Post, manager of Continental's Industrial Relations department. Hovlid will continue to make his headquarters in Ponca City.

Hovlid

Hovlid started with Continental in 1923, as a chemist, at Florence, Colo. A native of Longmont, Colo., he was awarded his chemical engineering degree at the University of Colorado and also was an instructor there for a short period.

He served for five years as superintendent of the company's Glenrock, Wyo., refinery, and was promoted to assistant to the research chemist, Ponca City, in 1933. Appointed assistant to the refinery manager the same year, he became personnel supervisor in the manufacturing department in 1948.

Drastic Increase In Instrument Demand Noted

Demand for scientific apparatus and process instruments for basic defense industries is running 250 to 300 percent above pre-Korean levels according to a statement made by Henry F. Dever. Dever's firm, the Brown Instruments Division of Minneapolis-Honeywell, is having difficulty obtaining sufficient critical materials to handle the expanding production of process instruments.

"The engineering challenge facing America today is to break down complicated industrial process operations into simpler tasks where bobby-soxers and oldsters can do the work of scarce, skilled workers. An economy of guns and butter presents more engineering and manpower problems than we had early in World War II since we do not have the eight million unemployed to draw from now that we had then," said Dever.

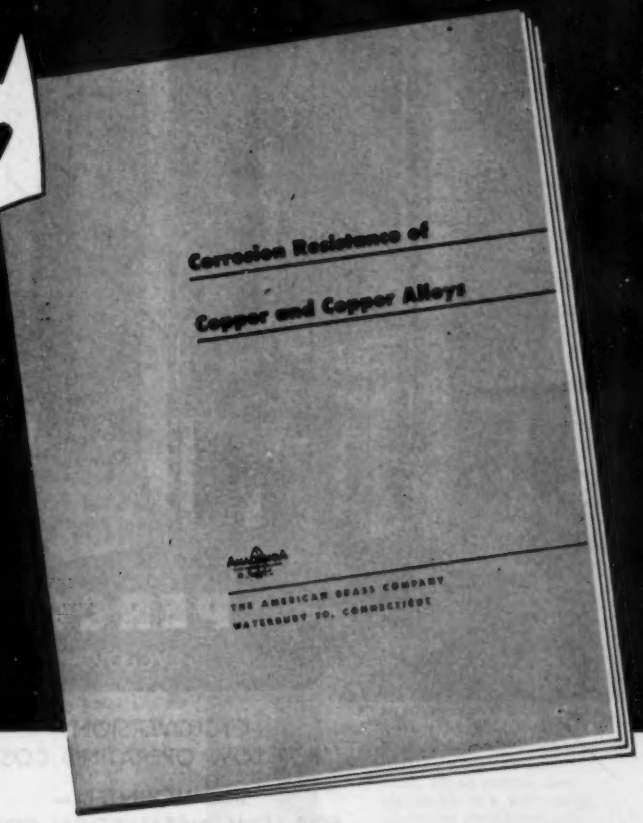
The process instruments industry is not large in dollar volume or requirements for essential materials but the 15 or 20 companies that specialize in these devices "provide the catalyst that speeds output in vital industries," he said. He pointed out that the $60 to $100 million annual process instruments industry is vital to the $25 billion or more of goods essential to the war effort.

Recognition of instruments as the

New Corrosion Data!

YOU WILL WANT THIS IMPORTANT BOOKLET

containing a new collection of data on corrosion resistance of copper and copper alloys.



For operators and designers of:

Process Equipment
Heat Exchangers
Condensers
Evaporators
Chemical Equipment
Waterworks and Sewage Plants

This new booklet presents in concise, usable form important technical discussions and data on the corrosion resistance of copper and copper alloys. Here are the subjects included:

- **Theory of Corrosion and Types of Corrosive Attack**
- **General Discussion of Corrosion Resistance of Copper Alloys**
- **Corrosion Rating Charts**
- **Typical Industrial Uses of Copper Alloys**
- **Composition, Mechanical and Physical Properties of Copper Alloys**

SEND FOR YOUR FREE COPY TODAY!

where corrosion resistance counts — consider

ANACONDA®
COPPER AND COPPER ALLOYS

The American Brass Co., Waterbury 20, Conn. (In Canada: Anaconda American Brass Ltd., New Toronto, Ontario.)

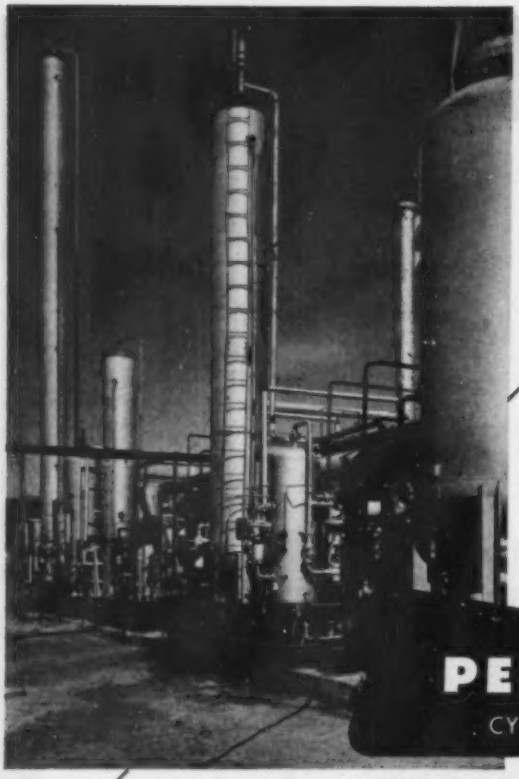
Please send me my copy of your new booklet, "Corrosion Resistance of Copper and Copper Alloys."

NAME.....

COMPANY.....

STREET.....

CITY.....ZONE.....STATE.....



PERCO
CYCLOVERSION

CYCLOVERSION —
FOR LOW OPERATING COST

SKID-MOUNTED —
FOR LOW INSTALLATION COST

PREFABRICATED —
FOR LOW CONSTRUCTION COST

Gladewater Refining Company recently installed this Perco Cycloversion unit to reform straight run gasoline or desulfurize cracked stocks at the rate of 600 barrels per stream day. Engineering and construction were by Grebe & Doremus Process Co., Houston, who shop fabricated the unit and mounted it on three skids for installation on site. Write us about Cycloversion for you!

A SERVICE MARK

PERCO DIVISION
PHILLIPS PETROLEUM COMPANY
BARTLESVILLE, OKLAHOMA

The MONTH . . .

fastest method for expanding industrial production accounts for the unusual demand, according to Dever. Brown Instruments Division will sub-contract orders as part of their program to meet demands. The Business Development Center, sponsored by the Philadelphia Chamber is screening sub-contracting bids it receives for work wanted by the Brown organization.

Chesney Joins Deep Rock As Cushing Plant Manager

Managership of Deep Rock Oil Corporation's refinery at Cushing, Okla., has been given to Robert M. Chesney, an oil industry employe since 1934. A graduate of the University of Delaware with a B.S. degree in chemical engineering, he began his career with Socony Vacuum Oil Company as a chemist and progressed to foreman by 1940. In 1949 he was made superintendent of Socony Vacuum's second largest refinery located at Paulsboro, N. J. Chesney fills the vacancy created by the resignation of K. O. Stowell.

Reginald Pigott Slated as Next President of ASME

Nominations for ASME offices were announced early this month and revealed that Reginald J. S. Pigott, director of the engineering division of Gulf Research & Development Company of Pittsburgh, a subsidiary of Gulf Oil Corporation, will be elected 1952 president of the society when the letter ballots are cast this fall. Nomination is tantamount to election as only one name is presented for each office.

Pigott

Pigott has been director of engineering research of Gulf Research & Development since 1929. Author of more than 40 technical papers, his subjects have included power station design, fluid flow, instruments, vapor lock, lubrication, super-chargers, and aviation fuel and lubrication systems. In addition, he holds more than 30 patents on devices used in hydraulic engineering, heating, oil production, and instruments.

Born at Wellington, England, in 1886, he was educated in New York and earned a mechanical engineering degree at Columbia University in 1906. In 1946 he received the University Medal. His experience includes a year of teaching at Columbia, as well as practical service as draftsman, engineer, superintendent of construction, and consulting engineer for various firms.

Past president of the SAE and ISA and first president of the ASMC, Pigott is a member of Theta Xi and Tau Beta Pi, Sigma Tau and Sigma Xi.

Regional vice presidents nominated are: Willis Frederick Thompson, Westcott & Mapes, Inc., New Haven, Conn.; Ernest Henry Hanhart, Baltimore, Md.; Ernest Stephen Theiss, Davey Com-

FOR
HEAVY DUTY
SMALL SPACE
BIG CAPACITY
HIGH HEAD PUMPING
SPECIFY
PACIFIC
Type WY
VERTICAL CENTRIFUGAL
PUMPS
Built in single and multi-stage to meet head requirements.
The design of WY Pumps has been developed to combine simplicity and accessibility with essential strength and sturdiness for continuous operation with sustained efficiency over long periods of time. These pumps are applicable to a wide range of service conditions and may be fabricated from any material of commercial availablity.
Economical
SPACE—Requires a minimum of floor space.
POWER—High efficiency requires a minimum of power.
MAINTENANCE—Sturdy, simple construction. Only one packing box. Easy to remove, dismantle and reassemble.
Balanced
DYNAMICALLY—Impellers dynamically balanced.
RADIALLY—Diffusers insure perfect radial balance.
HYDRAULICALLY—For minimum load on thrust bearing.
Capacity
GPM TO—7000.
DISCHARGE PRESSURE—To 300 psig.
Write for Bulletin 105
PACIFIC Precision Built PUMPS
Pacific Pumps inc.
HUNTINGTON PARK, CALIFORNIA
Export Office: Chanin Bldg., 122 E. 42nd St., New York
Offices in All Principal Cities
CP-2

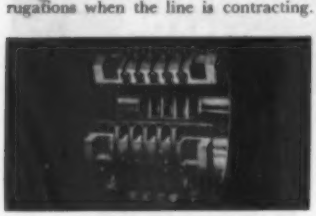
Zallea Expansion Joint News

PUBLISHED BY ZALLEA BROTHERS—WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

Expansion Joint of the Month

DUO EQUALIZING TYPE

The ideal corrugated expansion joint is one in which all corrugations move simultaneously during expansion or contraction of the piping, and no corrugation can be compressed or extended more than the proportionate amount for which it is designed. This briefly describes the Zallea Duo Equalizing Expansion Joint, so called because it functions in two ways: equalizing the compression among the corrugations simultaneously when the pipe line is expanding and likewise distributing the elongation simultaneously and proportionately among all the corrugations when the line is contracting.



This is accomplished by the simple expedient of a pantograph. Two or more pantographic chains are superimposed on the equalizing rings of the expansion joint, the neutral points being anchored in the end fittings and intermediate equalizing rings. Any movement of the end fitting is immediately and simultaneously transmitted to all equalizing rings. In this manner all the equalizing rings move the same relative distance at the same time. This Zallea Joint is recommended for all intermittent steam services in long lines, institutions, and industrial plants.

. . . a brand new 4-page folder on *all* Zallea Expansion Joints. Send for your copy of Bulletin 351 today!

ZALLEA BROTHERS, 890 Locust Street, Wilmington 99, Delaware.

WORDS YOU DON'T EXPECT:

"Guaranteed Delivery"

Restrictions . . . allotments . . . priorities . . . material shortages . . . backorders . . . uncertainty . . .

Take your choice . . . these are familiar words to industrial buyers today.

Not too often, however, does the industrial buyer hear those seemingly long-lost words, "Guaranteed Delivery".

This is especially true about stainless steel expansion joints.

You've all heard the well-worn "we'll-take-your-order" routine. But delivery date? That's something else again!

Like many an industrial faced with expansion problems, you know all-too-well that you can't afford to risk shutdowns today because of unsatisfactory or inadequate expansion joint performance. Production *must* be kept moving at the required fast pace.

Here's the unexpected!

We are in a position to fill your standard expansion joint needs . . . promptly! (6 weeks on large orders, 4 weeks on medium orders and *2 to 3 days on emergency orders, if necessary.*)

The reason isn't too unusual. As the world's largest manufacturers of expansion joints, we maintain, at all times, a complete stock of component parts. Many months ago, we here at Zallea Brothers anticipated today's critical material situation, and did something about it. Today, we have an adequate supply of stainless steel *on hand*. We do not have to wait for mill deliveries.

We realize, however, that our stocks won't last forever . . . far from it. But so long as we can keep turning out *quality* expansion joints that will give you the lasting performance you want, you are assured of *guaranteed delivery* on all Zallea standard units.

Sol Zallea

The MONTH...

pressor Company, Kent, Ohio; Samuel H. Graf, Oregon State College, Corvallis, Ore.

Nominated as directors-at-large are: Albert Carl Pasini, The Detroit Edison Company, Detroit; and Paul B. Eaton, Lafayette College, Easton, Pa.

Gulf Oil Appoints Lutz

Cedric W. Lutz assumed his new duties as director of purchases for Gulf Oil Corporation, Pittsburgh, early this month. As such he will handle all purchases made in the U.S. by all Gulf companies and will be responsible for determining purchasing policies and procedures for all the companies' domestic divisions and districts. Formerly assistant to the vice president in the Houston Production Division, Lutz succeeds Lee C. Bock, general purchasing agent who died earlier this year.

Reports Record Thruput

Consumers Co-operative Association reports that four of its member refineries set a new processing record in May when they produced 899,465 barrels of crude oil, topping the previous peak of July, 1950, by 73,943. The average for May was 29,015 barrels or 107.26 percent of rated capacity of 27,050 barrels daily. Coffeyville, Kans., the largest of the four, rated at 19,000 barrels, averaged nearly 22,000 barrels throughput daily. Other plants are located at Phillipsburg, Kans., Scotts Bluff, Nebr., and Newcastle, Wyo.

Announce New Offices

New general offices for Calumet Refining Company have been opened at Burnham, Ill., acording to C. A. Haris, vice president and general manager. Mailing address for the company is 13921 Mackinaw Avenue, Chicago 33.

Rodgers Elected Chairman

W. S. S. Rodgers, board chairman of The Texas Company, was elected chairman of the board of Arabian American Oil Company, succeeding H. D. Collier, who had served since 1940. Collier remains as director.

Aetna Advances Alexander

Clive M. Alexander was elected executive vice president of Aetna Oil Company effective June 23. Prior to the recent merger of Aetna Oil Combany with Ashland Oil and Refining Company, Alexander, who resides in Louisville, Ky., served as vice president in charge of manufacturing and transportation.

Badger Announces Merger With Stone & Webster

Engineering and construction services for the chemical, petro-chemical, petroleum and pharmaceutical industries formerly engaged in by E. B. Badger & Sons Company and Stone & Webster Engineering Corporation's process division will be carried on hereafter by the Badger Process Division of Stone & Webster Engineering Corporation.

Erastus B. Badger, formerly president of E. B. Badger & Sons Company, was elected a director of Stone & Webster

Treat Cooling Water *with Chlorine* — the Proven Way

HELP MAINTAIN MAXIMUM PLANT EFFICIENCY..

Hundreds of power plants and refineries have found chlorination by W&T the answer to heat exchanger slime problems. By eliminating slime forming microorganisms, maximum heat transfer is maintained in the condensers. The result — overall plant efficiency is kept at a maximum.

REDUCE LABOR COSTS...

High labor costs involved in frequent condenser tube cleaning are eliminated when chlorination is employed. Manhours used for tube cleaning can be utilized for other maintenance jobs, an important factor with the increasing manpower shortage.

REDUCE DOWN TIME...

Elimination of frequent shut-down for tube cleaning helps power plants stay continuously "on the line." When chlorination is employed, many plants find that outage for cleaning is reduced to once per year and then only for removing trash from tube sheets.

W & T Air Operated Visible Vacuum Chlorinator

Years of operation have proved the dependability and accuracy of W&T Chlorinators for cooling water treatment. Low maintenance and automatic program operation keep operating costs to a minimum. Your W&T Engineer is prepared to make a survey of your plant to recommend the proper chlorination equipment. Write today for more information on slime control — no obligation, of course.

CD-35

WALLACE & TIERNAN PRODUCTS, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
Belleville 9, New Jersey • Represented in Principal Cities

The MONTH...

Engineering Corporation, and Ralph D. Waterman, formerly vice president of the Badger Company, was named a vice president of Stone & Webster Engineering Corporation.

1950 Petroleum Increases Detailed in Bank Study

General operational increases were realized during 1950 by the petroleum industry in the United States, according to a Chase National Bank study which covers in detail the activities of 30 companies. A gain of 11.6 percent was shown for gross operating income, and a 12.1 percent increase in total income. The combined net earnings of the 30 companies, which comprise about two-thirds of the industry, amounted to $1739 million while total income was $15,574 million.

Taxes charged to income increased 46.1 percent over 1949 and totalled $1150 million. The 30 companies collected nearly $2 billion in consumer taxes on their products for various government agencies.

Cash dividends on preferred and common stocks amounted to $686 million, the largest disbursement in petroleum history, an outlay representing 39.4 percent of available earnings.

The study, "Financial Analysis of Thirty Oil Companies for 1950," prepared by Frederick G. Coqueron and Joseph E. Pogue of Chase's Petroleum Department, shows the working capital of the group to be $3852 million at the end of 1950, an increase of $414 million over 1949.

Principal declines from the previous year in the group's financial picture were in the categories of capital expenditures, outstanding debt and new financing. A decline of 17.1 percent was noted for capital expenditures which aggregated $1894 million in 1950. Net reduction of debt amounted to $181 million while new financing totalled only $159 million, compared with a peak of $682 million in 1947. Borrowings accounted for $152 million of the new financing and $7 million resulted from the sale of common stock.

Processed crude oil volume, by both domestic and foreign refineries, set a new record of 5,729,000 barrels per day average for an increase of 9.3 percent over 1949. The combined world-wide crude production of the group averaged 3,669,000 barrels daily, an increase of 6.5 percent over 1949.

Reporting for the whole industry, the report stated that the rate of refining operations and consumption of petroleum products set all time records. Domestic requirements rose some twelve percent while world demand for petroleum products passed ten million barrels per day for the first time in history. (These figures do not include Soviet-controlled areas.)

Crude production and refining capacities in the United States have increased about one-third since 1946 as a result of capital expenditures amounting to approximately $12.3 billion. This outlay was distributed as follows: production 61.4 percent; transportation, 10.2; refining, 15.8; marketing, 10.1; other, 2.5. At the end of 1950 the total gross assets employed by the U. S. petroleum industry were $32.9 billion.

PERFECT ISA MEETING PLANS—Plans for the ISA Sixth National Conference and Exhibit scheduled for September 10-14 at the Sam Houston Coliseum and the Music Hall, Houston, were perfected last month under the guidance of Richard Rimbach, executive secretary. Exhibits will include 219 booths to make the 1951 exhibit the largest yet held by the Society. Committeemen working out final arrangements were: Front row, left to right: C. R. Miller, Mechanics Maintenance Clinic chairman; Porter Hart, national vice president and Cooperating Societies chairman; J. R. Martin, general conference and exhibit chairman; R. E. O'Neill, program committee chairman; I. K. Farley, committee secretary; R. D. King, Houston section president and reception committee, chairman. Back row, left to right: R. L. Springfield, entertainment committee; C. W. Bates, co-chairman of the conference and exhibit committee and publicity chairman; R. E. Hansen, Analytical Clinic chairman; G. A. Hubert, entertainment committee; W. B. Rawson, invitations committee chairman; W. H. Fortney, advisory chairman; Richard Rimbach, executive secretary of ISA.

Chemicals Wanted

The National Registry of Rare Chemicals, Armour Research Foundation, 33rd, Federal and Dearborn Streets, Chicago 16, has received urgent requests for the chemicals listed below. If anyone has one or more, even if only one gram quantities, please inform the Registry.

Triphenylmethyl mercaptan
sym.-Triisopropyl toluene
Tetraphenylarsonium chloride
n-Octyl benzene
2-Methyl1-1,2-diaminopropane
Indene
2-Ethylanthraquinone
2,4-Dihydroxypyridine
Pyrene-2,10-quinone
cis-9,10-Dicarboxydecalin
1-Cyclohexylindane
para-Methoxythiophenol
2,6-Dichlorodiphenylamine
1-Cyanobutene
2,4-Dibromohexane
2,4-Dimethyl-3-pentanethiol
Cyclobutane
1,8-Dichlorooctane
4-Bromocyclohexanone
Decafluorocyclopentane

Trends of Operations and Changes in Stocks

Figures on crude stocks are from Bureau of Mines weekly reports; all others from American Petroleum Institute weekly reports, which are estimates on Bureau of Mines basis.
(All figures in thousands of barrels—add 000)

Trends in Week Ended	Crude Oil			Gasoline		Gasoil and Distillate		Residual Fuel	
	Production Daily	Runs to Stills Daily	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End	Production Weekly	Stocks Week End
1950:									
January 28	4,956	5,470	248,411	18,363	124,270	7,302	66,337	8,389	37,036
February 25	5,000	5,277	245,586	17,703	133,888	6,890	56,056	7,855	48,663
March 25	4,848	5,469	244,227	17,839	135,406	6,870	40,577	8,171	42,546
April 29	5,014	5,314	244,744	18,038	128,655	6,531	38,686	7,272	39,260
May 27	5,116	5,591	240,842	18,704	122,757	7,201	40,607	7,421	39,308
June 24	5,355	5,636	240,762	19,626	115,036	6,868	50,580	7,461	41,291
July 29	5,522	5,870	240,236	19,981	109,076	7,266	61,437	7,870	42,253
August 26	5,699	6,197	236,934	20,263	105,793	7,550	65,841	8,543	41,697
September 30	5,903	6,051	241,631	19,624	104,383	8,460	76,734	8,306	42,330
October 28	6,005	6,051	244,908	19,878	105,092	8,259	84,057	8,449	44,310
November 25	5,888	6,238	244,497	19,547	105,424	8,591	86,766	8,470	45,566
December 23	5,763	6,150	250,799	20,075	112,631	9,436	73,273	8,715	39,914
1951:									
January 27	6,056	6,483	244,230	21,106	126,261	9,954	58,907	9,905	40,378
February 24	5,954	6,524	237,204	20,815	136,870	10,545	48,764	9,471	38,995
March 31	6,041	6,381	235,956	20,398	142,186	9,365	43,170	9,147	37,282
April 28	6,154	6,236	242,479	19,876	137,474	8,961	43,850	8,747	36,080
May 26	6,163	6,430	246,400	21,102	130,819	8,590	51,344	9,045	37,365
June 23	6,192	6,649	247,509	22,107	127,736	8,806	62,969	9,295	40,647

Sun Oil Technical Unit Is Recalled to Army Duty

The 461st Strategic Intelligence Research and Analysis team, one of ten Sun Oil Company-sponsored Army reserve units, recalled to active service, reported to Schuylkill Arsenal, Philadelphia, for assignment on July 1.

The unit, formed in the summer of 1949 as part of the Department of Defense Affiliation Program in which industrial organizations sponsor certain

Finishing Building with Boiler Plant in left background

FROM REPORTS . . . *to Producing Plant*

For Lever Brothers Limited, Stone & Webster Engineering Corporation prepared a series of reports covering alternative plans for consolidation and expansion of the company's manufacturing facilities in Toronto.

The resulting new plant facilities, selected to achieve more efficient and economical operation, were designed and constructed by Stone & Webster Engineering Corporation.

Left to right, Boiler Plant, Glycerine Refinery and Finishing Building which includes manufacturing equipment for soap products and toilet preparations.

STONE & WEBSTER ENGINEERING CORPORATION

A SUBSIDIARY OF STONE & WEBSTER, INC.

AIRCO HARDFACE-LIFTING

makes old parts new . . . and new parts better

With today's delays in replacements, dollars offer less and less protection when tools or equipment wear out. No chance of cut-backs, or loss of day-to-day production, if wearing areas are fully protected with Airco Hardfacing Alloys . . . new parts and old stay on the job longer—even at peak production.

No matter what the part, or tool . . . fishtail bits . . . roller bits . . . core heads . . . wall scraper blades . . . drag type drilling bits . . . their life is extended many times by using Airco Tung Tube.

There are more than fifteen types of Airco Hardfacing rods available . . . for protection from every type of wear. Two other alloys widely used in oil field service are Aircoloy 1 and 6, for hardfacing equipment to resist corrosion and temperatures above 700°F. Both alloys have been built to resist abrasion at high temperatures.

Wear is a serious problem in your operations! It will pay you to investigate Airco Hardfacing Alloys. An Airco representative will be glad to give you complete information. Get in touch with your local Airco office today.

a few AIRCO hardfacing alloys

AIRCOLOY® No. 1

A non-ferrous, hardfacing alloy consisting of cobalt, chromium and tungsten . . . excellent corrosion resistance . . . retains hardness and wear resistance even at red heat . . . cold hardness of 53 to 57 on Rockwell "C" scale. May be used wherever heat, abrasion and corrosion are involved. Aircoloy No. 1 is furnished bare for oxyacetylene application and coated for electric arc welding.

AIRCOLOY® No. 6

Excellent corrosion resistance . . . high impact and good wear resistance with some degree of ductility . . . retains hardness and wear resistance at red heat . . . cold hardness of 43 to 47 Rockwell "C". May be used wherever heat, impact, abrasion and corrosion are involved.

AIRCOLITE No. 59

These cast alloy rods are recommended for application wherever abrasion resistance is particularly important. Deposits acquire a high polish in service, and maintain their high hardness at temperatures up to 800° F. Applied either electrically or by gas process. Deposits test from 54-59 on Rockwell "C" scale.

★ ★ ★

Air Reduction supplies Oxygen, Acetylene and other industrial gases . . . Calcium Carbide . . . and a complete line of gas cutting machines, gas welding apparatus and supplies, plus arc welders, electrodes and accessories. Ask us about anything pertaining to gas welding and cutting and arc welding . . . we'll be glad to help you.

AIR REDUCTION MAGNOLIA COMPANY

A Division of Air Reduction Company, Incorporated

Beaumont • Corpus Christi • Dallas • El Paso • Fort Worth • Hobbs
Houston • Oklahoma City • San Antonio • Shreveport • Tulsa • Wichita Falls

Southwestern Headquarters for Oxygen, Acetylene and Other Gases . . . Carbide . . . Gas Welding and Cutting Machines, Apparatus and Supplies . . . Arc Welders, Electrodes and Accessories

The MONTH...

key service-type units of the Organized Reserve Corps, originally it was composed entirely of Sun personnel, but as a result of transfers the enlisted men are now from other companies.

Sun's other reserve units include five from the general office, three from Marcus Hook and one from Toledo, Ohio.

Howard Berry Joins Aries Financial Department

Howard Berry, former official and director of Mathieson Chemical Corporation, has joined R. S. Aries and Associates, New York consulting engineers and economists, as senior associate. Berry had been with Mathieson for 28 years in an executive financial capacity and had been with the Remington Arms Company and the American International Corporation previous to that. Berry's efforts with Aries will be devoted to acquisitions, mergers, cost reduction, profit estimates and financial reports.

Berry

The Aries organization specializes in the chemical process industries.

Stan-Vac Gives President New Executive Power

Coincident with an organizational change that transferred executive power from the chair to the president, P. W. Parker was elected president of Standard-Vacuum Oil Company and will be succeeded as chairman of the board by L. V. Collings. H. W. McCobb and H. F. Prioleau were elected vice presidents.

Edward N. Leibacher, a newly elected board member, has been associated with international oil industry for 35 years, and has held technical and managerial posts in the U. S., Europe and Sumatra.

George F. James, also elected a director, taught law and practiced as an attorney before joining Standard-Vacuum in 1944.

Harold Midtho, assistant treasurer since 1942, succeeds James as company treasurer.

Cities Service Division Promotes Wilson, Wirges

J. W. Wilson was named superintendent of operations and M. F. Wirges, chief process engineer for the gasoline-chemical division, Cities Service Oil Company (Delaware), recently. In connection with these added responsibilities, Wilson and Wirges will work under the direct supervision of Ralph W. Johnston and Harry P. Hohenadel, general superintendents of the gasoline and chemical divisions, respectively.

Brandli Elected President

H. E. Brandli of New York, who was elected president of Cities Service Oil

Get TWICE the value for your steam trap dollar!

Just as the self-starter revolutionized the automobile, so Clark Duo-Step Leverage is changing old-fashioned ideas about steam trap efficiency.

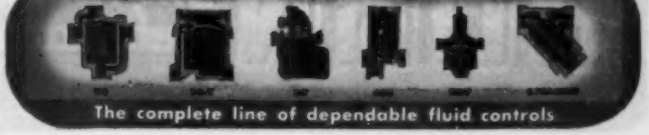
Field and laboratory tests prove that Clark DUO-STEP Steam Traps more than *double* the drainage capacity of ordinary inverted bucket traps.

Ask your Clark representative for a demonstration on your steam lines—or write us for complete information.

Here's how DUO-STEP doubles drainage capacity

THE CLARK MANUFACTURING COMPANY
1847 East 38th St. • Cleveland 14, Ohio

Clark
THE HOME OF DUO STEP LEVERAGE



The complete line of dependable fluid controls

Your Inquiry Will Receive Our
Immediate Attention.

BORN *Engineering Company*

ENGINEERS and CONTRACTORS

TULSA, OKLAHOMA

LOS ANGELES, CALIF., SHREVEPORT, LA., NEW YORK CITY, N. Y., HOUSTON, TEXAS

Canadian Associates: BRANDON, MANITOBA, Canadian Brown Steel Tank Co., Ltd.

Company (Pennsylvania) last month, succeeds Burl S. Watson, new chairman of the executive committee. Brandli, formerly vice president and general manager of the company, is a veteran Cities Service executive. His activities have included key managerial positions in Illinois, Texas, Kansas, Mississippi and Alabama.

Hose and Arnold Moved To New York in Promotion

The Texas Company recently promoted two men who have been with the company since 1927, to Texaco headquarters in New York.

Harold C. Hose, who has held various positions in the Refining Department and has been associated with the company's foreign operations since 1944, was named assistant to Executive Vice President A. C. Long.

H. H. Arnold, Jr., former assistant to the manager of the Producing Department at Houston, was appointed manager of Foreign Operations in the Eastern hemisphere.

Lobban Joins Deep Rock

Appointed night supervisor of the process department of Deep Rock Oil Corporation's refinery at Cushing, Okla., Fred P. Lobban will move to Oklahoma from New Jersey where he has been employed in process design and engineering with the Texas Company for the past five years. Lobban holds an M.S. degree from M.I.T. (1941).

IPAA Names Committee To Study Petroleum Supply

A committee appointed by the Independent Petroleum Association of America will study the supply and availability of petroleum in the western hemisphere. Charlton Lyons, independent operator of Shreveport, La., was named chairman, with L. Dan Jones, Washington, D. C., secretary. The committee has been charged to study four problems.

Availability of oil in the western hemisphere; sources of supply; means of building excess productive availability for future industry exploration for emergency defense requirements; and recommendations for legal means of correlating various sources of supply to encourage progressive growth without injury to individual areas.

Committeemen include:

Clyde H. Alexander, Dallas; J. S. Bridwell, Wichita Falls, Texas; Frank Buttram, Oklahoma City; F. Allen Calvert, Jr., Olney, Ill.; J. P. Coleman, Wichita Falls, Texas; F. J. Dangiade, Lovington, N. M.; Paul L. Davis, Midland, Texas; John T. Diederich, Ashland, Ky.; Forest Dorn, Bradford, Pa.; F. Julius Fohs, Houston; Wirt Franklin, Ardmore, Okla.; and W. L. Goldston, Houston.

Lawrence R. Hagy, Amarillo, Texas; John W. Hancock, Long Beach, Calif.; R. A. Hardey, Shreveport, La.; I. W. Hartman, Mt. Pleasant, Mich.; R. N. Hunt, Salt Lake City; A. Jacobsen, New York; Raymond Lamb, Artesia, N. M.; A. I. Leversen, Tulsa; M. R. McArthur, Cody, Wyo.; A. C. Mattei, San Francisco; and Gilbert J. Mueller, Denver.

C. H. Murphy, El Dorado, Ark.; H. M. McClure, Jr., Alma, Mich.; R. W. McDowell, Tulsa; R. W. McIlvain, Chicago; Maston Nixon, Corpus Christi, Texas; R. B. Parriott, Wichita, Kan.; V. C. Perini, Jr., Abilene, Texas; A. S. Ritchie, Wichita, Kan.; French M. Robertson, Abilene, Texas; A. H. Rowan, Fort Worth; R. S. Shannon, Denver; Fred W. Shield, San Antonio; Arthur Simmons, Bradford, Pa.; W. W. Smith, Philadelphia; W. L. Stewart, Fort Worth; Lawrence Vander Lock, Los Angeles; and W. M. Vaughey, Jackson, Miss.

Texaco Opens Detroit Technical Service Office

A new technical service field office which will maintain close working liaison with the automotive industry has been opened in Detroit by the technical and research division of The Texas Company. Similar offices are maintained in Houston, Los Angeles and Chicago.

K. L. Hollister, technical representative, and manager of the new Texaco office, will cooperate with manufacturers of passenger cars, busses, trucks and allied equipment on problems relating to fuels and lubrication. He will also coordinate Texaco's research activities as they touch on fuels problems. Hollister graduated from the University of Michigan as a mechanical engineer in 1926, then worked for the Ingersoll-Rand Company six years before joining The Texas Company where he has been principally active in the fields of technical and manufacturers' service.

The MONTH...

Short Course Scheduled At Oklahoma University

The Oklahoma Utilities Association has scheduled the 1952 Southwestern Gas Measurement Short Course at North Campus, University of Oklahoma, Norman, Okla. The school will be held April 8, 9, 10 of 1952, according to Kate A. Niblack, secretary.

You Get the Finest..

ORIFICE PLATES

When they are manufactured by INDUSTRIAL INSTRUMENT CORP.

- HANDLE TYPE ORIFICE PLATES!
- PLATES FOR ORIFICE FITTINGS!

MANUFACTURED AND MACHINED TO A G A RECOMMENDATIONS

IMMEDIATE DELIVERY!

PRICE LIST
Handle Type — Orifice Plates
In ordering, specify flange rating

Size	Chrome-Moly Steel	Stainless Steel Type 302 or 304	Additional Charge for Boring
1½"	$3.60	$4.80	$1.50
2	3.60	4.80	1.50
3	4.35	5.60	1.50
4	4.80	6.35	1.50
6	5.60	7.15	1.50
8	6.40	11.10	2.50
10	7.60	14.80	2.50
12	8.80	19.30	2.50
14	10.80	20.75	2.50
16	13.30	23.90	4.00

Above Prices Are for ¼" Standard Material. Prices on other sizes and thicknesses on request.

PRICE LIST
Orifice Plates for Orifice Fittings
In ordering, specify type of fitting

Size	Chrome-Moly Steel	Stainless Steel Type 302 or 304	Additional Charge for Boring
1½"	$1.80	$2.40	$1.50
2	1.80	2.40	1.50
3	2.00	2.70	1.50
4	2.15	3.00	1.50
6	3.00	5.00	1.50
8	3.90	7.10	2.50
10	4.50	10.30	2.50
12	4.90	13.50	2.50
14	5.10	16.20	2.50
16	6.00	19.20	4.00

Above Prices Are for ¼" Standard Material. Prices on other sizes and thicknesses on request.

Visit the Sixth National Instrument Exhibit at the Sam Houston Coliseum in Houston, Texas, September 10-14, 1951. See our display in Booths 732 and 734.

INDUSTRIAL INSTRUMENT CORP.

P. O. BOX 1909 ODESSA, TEXAS

"KARBATE" BRAND IMPERVIOUS GRAPHITE HEAT EXCHANGERS *FOR ALL PURPOSES!*

The "Karbate" impervious graphite heat exchangers illustrated are used extensively as boilers, coolers, condensers, vaporizers, evaporators, heaters and absorbers in handling corrosive chemicals, either hot or cold. They *all* can be had in a complete size range. *All of them* offer the following advantages:

- **Highest heat conductivity rate of the practical corrosion-resistant materials.**
- **Highly resistant to corrosion by acids or alkalis, hot or cold.**
- **Freedom from corrosion scale, as compared to metals.**
- **Immune to thermal shock.**
- **No contamination of product.**
- **Strong and easy to install and maintain.**

Shell-and-Tube: Series 70A—Two sizes, 16.4 sq. ft., and 24.6 sq. ft. of outside surface area respectively. Tubes easily replaced in the field. Interchangeable single and double-pass construction.

Series 240A—70.6 feet of outside heat transfer surface. Easy tube replacement. Easily converted on job to single, double, or four-pass tube side flow by simple change of fixed covers. Steel, shell, oversize shell connections, impingement plates and drain and vent plugs integral with shell end castings. Stainless-steel baffles assembled with steel tie rods to form protective cage for tube bundle. Removable "Karbate" tube bundle. Write for catalog sections for S-6690, S-6715 for details of applications, maintenance, sizes and characteristics of these exchangers.

Style FH heat exchangers (Size 1½): Are especially recommended for tanks with solution depths of 16 inches or less. Write for catalog section S-6750.

Cascade coolers: For all cooling jobs involving corrosive gases and liquids. Complete cooler assembly may be made quickly from 4 standard items in 5 pipe sizes. Capacity easily enlarged or reduced by adding or subtracting standard sections. Compact construction to save plant room. No special supporting structure needed. Write for catalog section S-6780.

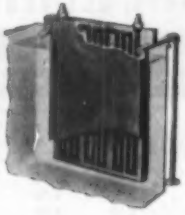


Plate heaters: Used to heat or cool corrosive liquids in tanks and vessels. Compact, completely assembled, easy to put in. Used in pickling, etching, plating and cleaning tanks. Complete size range. Models for horizontal and vertical mounting. Write for catalog section S-6620.

Concentric Tube exchangers: Available in two types. Series 10A is small, low-priced, gives true counterflow. Exceptionally good for small flow rates at narrow temperature differences . . . Series 20A manufactured with "Karbate" inner and outer piping, and is used to transfer heat between two corrosive fluids. Both have sectional construction, can be added to or subtracted from at will. Sturdy, can be moved from place to place after assembly, adapted to any method of mounting on floor, wall, or ceiling. Write for catalog section S-6670.

The term "Karbate" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices: Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

In Canada: National Carbon Limited
Montreal, Toronto, Winnipeg

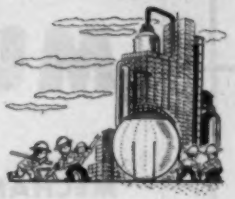
A full line of "Karbate" impervious graphite pipe and fittings

for conveying corrosive chemicals includes: "Karbate" pumps of advanced design embodying impervious graphite case, impeller, and a rotary seal which eliminates the stuffing box. Pump prices reduced up to 33%. Write for catalog section S-7000 for pipe information, S-7200 for pump information.

SCIENCE and TECHNOLOGY Abstracts

Prepared by
DR. E. H. LESLIE and DR. H. B. COATS
The Leslie Laboratories
Traver Road, Ann Arbor, Mich.

It's a Fact!



During 1950 oil companies invested $2 billion to expand and modernize facilities to provide more oil products for America.

Fundamental Physical and Chemical Data

2,2,4-Trimethylpentane (Iso-octane). Vapor Pressure, Critical Constants, and Saturated Vapor and Liquid Densities. WEBSTER B. KAY AND F. MORGAN WARZEL, *Ind. Eng. Chem.*, **43** (1951), pp. 1150-2.

As part of the study of the vapor-liquid equilibrium relations in binary systems, vapor pressure and orthobaric liquid and vapor densities of 2,2,4-trimethylpentane (iso-octane) were carefully measured. The vapor pressure measurements cover a temperature range from the normal boiling point to the critical point. The liquid density measurements started at 50° C. and the vapor density measurements at 205° C., both extending to the critical point. The vapor pressure in atmospheres at a temperature t° C. can be calculated accurately by the equation: $\log p = 4.45144 - 1657.71/(t + 273.160)$, when supplemented by the deviation curve. A table is presented giving the vapor pressure and liquid and vapor densities at regular temperature intervals. Data of the present investigation were compared with those of other investigators and the results of the comparison are presented graphically. A bibliography of eight references is included.

Thermodynamic Properties of Propylene. LAWRENCE N. CANJAR, MAX GOLDMAN, AND HENRY MARCHMAN. *Ind. Eng. Chem.*, **43** (1951), pp. 1186-93.

With the accurate measurements of the pressure-volume-temperature properties of propylene by several investigators, enough data were available to make calculations of the thermodynamic properties of this hydrocarbon. This the authors have done, and the results are presented in the form of tables and a pressure-enthalpy chart. These cover a range from the liquid at normal boiling point to a gas at 480° F. and 200 atmospheres pressure. A datum state was chosen where the enthalpy and entropy of the elements carbon and hydrogen in the ideal gas state and at 1 atmosphere and 0° K. are equal to zero. A bibliography of 18 references is included.

Experimental Vapor Heat Capacities and Heats of Vaporization of Seven Octanes. GORDON M. BARROW. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 1924-6.

Vapor specific heats at 130, 190 and 250° C., as well as the heats of vaporization, were measured for *n*-octane, 3-ethylhexane, 2,3-dimethylhexane, 3,4-dimethylhexane, and 2-methyl-3-ethylpentane, 3-methyl-3-ethylpenane and 2,3,4-trimethylpentane. The heat capacities of *n*-octane and 2,3,4-trimethylpentane were also measured at reduced pressure to obtain data on gas imperfection. From the average values of the gas imperfection corrections for these two compounds the heat capacities of all seven octanes in the ideal gas state were obtained. The comparison of the results for *n*-octane with those for *n*-hexane and *n*-heptane and with the statistically calculated values is given. From this it appears that, while the calculated values are essentially reliable, they tend to be about 1 percent high for the *n*-paraffin hydrocarbons.

The Viscosities of Organic Vapors. P. M. CRAVEN AND J. D. LAMBERT. *Proc. Roy Soc.* (London) Series A, **205** (1951), pp. 439-49.

The ratio of viscosity to thermal conductivity for a gas is a fundamental relation in the kinetic theory. However, data to be used for calculation are few. The viscosity of ethane, n-hexane, cyclohexane, benzene, methyl chloride, ethyl chloride, methyl alcohol, diethyl ether, acetaldehyde, acetone and acetonitrile were measured at temperatures of 35, 50, 65 and 78° C. and pressures between 1 and 3 cm. A linear relationship was found between coefficient of viscosity and temperature. The ratios of thermal conductivity to viscosity were calculated, using thermal conductivity values obtained recently in the same temperature range.

Rotational Isomerism and Thermodynamic Functions of 2-Methylbutane and 2,3-Dimethylbutane. Vapor Heat Capacity and Heat of Vaporization of 2-Methylbutane. D. W. SCOTT, J. P. MCCULLOUGH, K. D. WILLIAMSON AND GUY WADDINGTON. *Jour. Am. Chem Soc.*, **73**, (1951), pp. 1707-12.

The vapor heat capacity of 2-methylbutane was measured at five temperatures between 317 and 487° K. An equation is given to represent the results. The heats of vaporization at 279, 298 and 301° K. were found to be 6181, 5937 and 5901 cal./mole, respectively. An equation for the second virial coefficient, B, in the equation of state was obtained from thermal data. Thermodynamic functions were computed by the methods of statistical mechanics for 2-methylbutane and 2,3-dimethylbutane for selected temperatures up to 1500° K.

The Solubility of Aromatic Hydrocarbons in Water. ROBERT L. BOHON AND W. F. CLAUSSEN. *Jour. Am. Chem. Soc.*, **73**, (1951), pp. 1571-8.

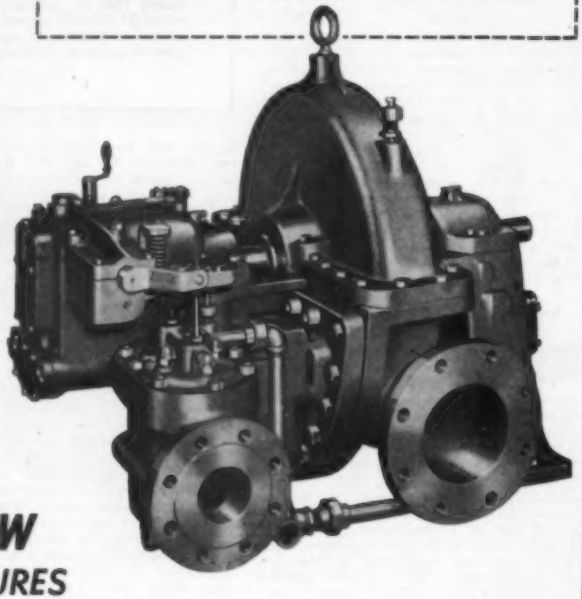
The solubilities in water of benzene, toluene, ethylbenzene, *m*-xylene, *p*-xylene, biphenyl and naphthalene were determined by ultraviolet spectrophotometric methods at temperatures between 0 and 40° C. All of the liquid hydrocarbons studies exhibited a solubility minimum near 18 degrees which corresponds to zero heat of solution. Some indication was found that interaction between water and aromatic hydrocarbons exists. The heat of solution of toluene in 0.4 molar silver nitrate solution indicates complex formation between the cation and the hydrocarbon.

Industrial Applications of Absorption Spectroscopy, The Spectroscopic Panel of the Hydrocarbon Research Group of the Institute of Petroleum. *Jour. Inst. of Petroleum*, **37** (1951), pp. 109-25.

This article deals briefly with the basic principles of spectra and then describes a few varied applications of an industrial nature. In the ultra-violet region of the spectrum only certain types of materials exhibit selective absorption. Among the hydrocarbons, aromatics, naphthalenes, and conjugated olefins have characteristic absorption, while the saturated hydrocarbons, both paraffinic and naphthenic, are transparent. Infra-red radiation, on the other hand, is absorbed by almost all gases, liquids, and solids, and the absorption is highly selective, certain wave-lengths being strongly absorbed while closely adjoining ones are not. The infra-red absorption spectrum of a compound is thus a unique pattern or "finger-print" characteristic of that substance, and is thus useful in identifying compounds. The

These abstracts from the current literature of science and technology (not including trade journals easily available) were prepared by Drs. Leslie and Coats of The Leslie Laboratories, Traver Road, Ann Arbor, Mich., which will supply, at cost, photostatic copies of original articles. Complete or limited bibliographies covering special topics by title, by abstracts, or in complete manuscript, also may be had by arrangement with the laboratories.

NEW!
MURRAY
TYPE H
MECHANICAL DRIVE SINGLE STAGE STEAM TURBINE



NEW FEATURES

- Enclosed 'shaft-through' governor
- Fast acting hand speed changer
- Improved spark proof emergency stop
- New convenient hand valve position
- Easily removed governor valve and seat
- Removable perforated metal steam strainer
- Large bearing oil reservoirs
- Large finned-tube oil coolers
- Magnetic oil-drain plugs
- New type split oil rings
- Corrosion resistant carbon packing cases
- Chrome plated shaft under carbon rings

Combining a host of new improvements plus time tested features, the Murray Type H offers extra-value in a medium size machine. With a range of 50-200 H.P., depending upon speed and steam conditions, it is offered with either a 16" or 20" diameter wheel. 3" or 4" steam inlet sizes available. Steam conditions up to 600 lbs., 750° and back pressures up to 150 lbs. can be used.

Write today for full details.

MURRAY IRON WORKS COMPANY
BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

chart of characteristic infra-red absorption bands for various bonds or groups is included. Several typical applications of absorption spectra in industrial work are given. A bibliography of 17 references is included.

The Infra-Red and Raman Frequencies of Hydrocarbon Groupings. N. SHEPPARD. *Jour. Inst. of Petroleum*, **37** (1951), pp. 95-106.

Infra-red and Raman spectra provide information about the vibration frequencies of molecules. Although applied originally to simple molecules the techniques have been so improved that these spectra can be obtained relatively rapidly and many large molecules have been studied. The spectra can be only partially interpreted. These spectra have, however, many qualitative and quantitative analytical applications that are of general interest to chemists. It is the purpose of the present paper to give some account of these applications, particularly those of the qualitative type, in the hydrocarbon field. Infra-red and Raman spectra afford data that are to some extent complementary, and if maximum use is to be made of vibrational spectra for analytical purposes it is of advantage to obtain both types. Certain groupings within hydrocarbons give rise to characteristic frequencies which occur close to a particular position in the spectrum. These can be used to confirm or deny the presence of these groups in a substance of unknown structure. In the present paper the main aim is to give an account of these characteristic frequencies so as to illustrate the type of structural problem that can be successfully tackled by infra-red and Raman spectra methods. Characteristic spectra are given for acetylenes and olefins, and for various aromatics and naphthenes. A bibliograph covering infra-red spectra is included and one reference, giving Raman spectra of hydrocarbons, is also given.

Interfacial Properties of Hydrocarbon-Water Systems Interfacial Tension at Elevated Pressure and Temperature. II. Interfacial Properties of Hydrocarbon-Water Systems. A. S. MICHAELS AND E. A. HAUSER, *J. Phys. and Colloid Chem.*, **55** (1951), pp. 408-21.

The variation of interfacial tension between water and benzene or n-decane was determined in the pressure range 1 to 680 atmospheres and in the temperature range 30 to 200° C. Pressure causes a maximum deviation of about 10 percent over a pressure range of nearly 700 atmospheres. The effect of temperature is much greater than that of pressure in each case in both systems. Increased temperatures cause the significant decrease in interfacial tension. Approximate values of the molal latent heats of adsorption of benzene and n-decane at the water-hydrocarbon interface were calculated.

Flame Propagation. IV. Correlation of Maximum Fundamental Flame Velocity with Hydrocarbon Structure. R. R. HIBBARD AND B. PINKEL. *Jour. Am. Chem. Soc.*, **73** (1951), pp. 1622-5.

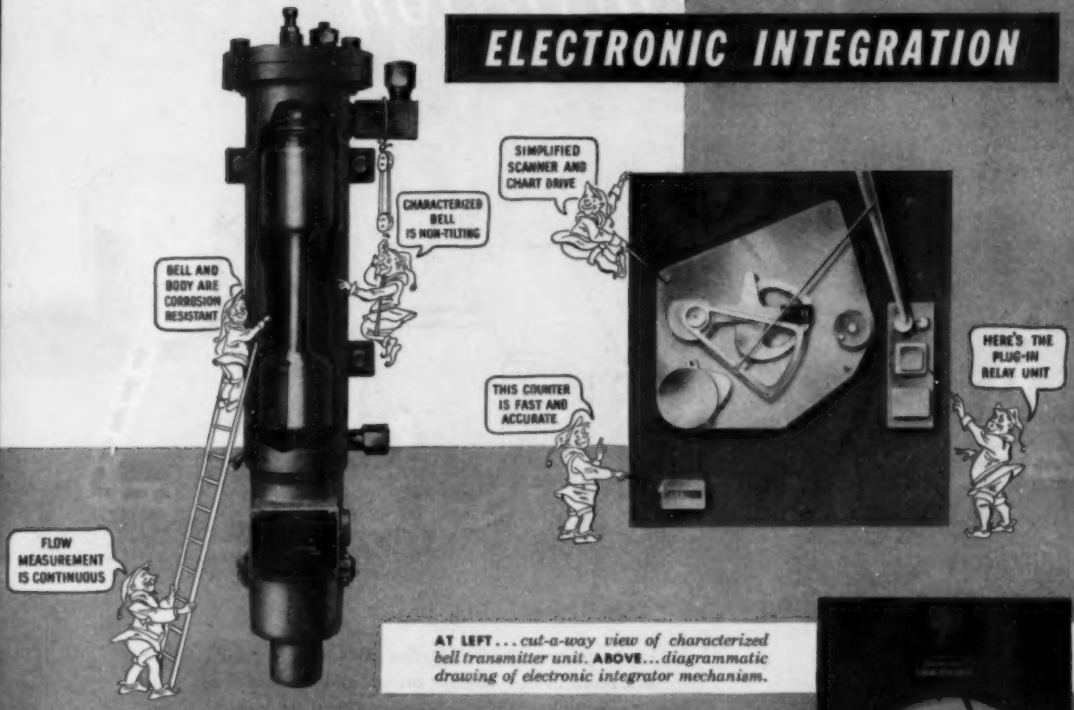
The authors have developed a correlation between the maximum fundamental flame velocity of hydrocarbons

Important Contribution to Flow Measurement and Accounting

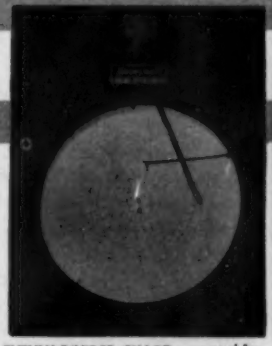
The New

Brown Electric Flow Meter *incorporates . . .*

ELECTRONIC INTEGRATION


SIMPLIFIED SCANNER AND CHART DRIVE
CHARACTERIZED BELL IS NON-TILTING
BELL AND BODY ARE CORROSION RESISTANT
THIS COUNTER IS FAST AND ACCURATE
HERE'S THE PLUG-IN RELAY UNIT
FLOW MEASUREMENT IS CONTINUOUS

AT LEFT . . . *cut-a-way view of characterized bell transmitter unit.* **ABOVE** . . . *diagrammatic drawing of electronic integrator mechanism.*



EVENLY-DIVIDED CHART . . . *provides easy readability for all rates of flow. Write for new Bulletin No. 293-1.*

HERE'S another important advancement for power and process instrumentation...continuous flow measurement, with electronic integration!

This Honeywell development eliminates intermittent measurement and slow, complicated totalizing...welcome news to process engineers and accountants.

The electronic integrator, consisting of but three major parts, simplifies accessibility and maintenance . . . permits quick checking and calibration. Scanning is rapid and extremely simple. The corrosion resistant meter body is of tubular construction, reducing weight and bulk. Electrical transmission permits remote, continuous recording of flow...and flow is easily totalized under all conditions. The characterized bell is corrosion resistant, too, and is specially designed to eliminate tilting.

Call in our local engineering representative for a discussion of your application.

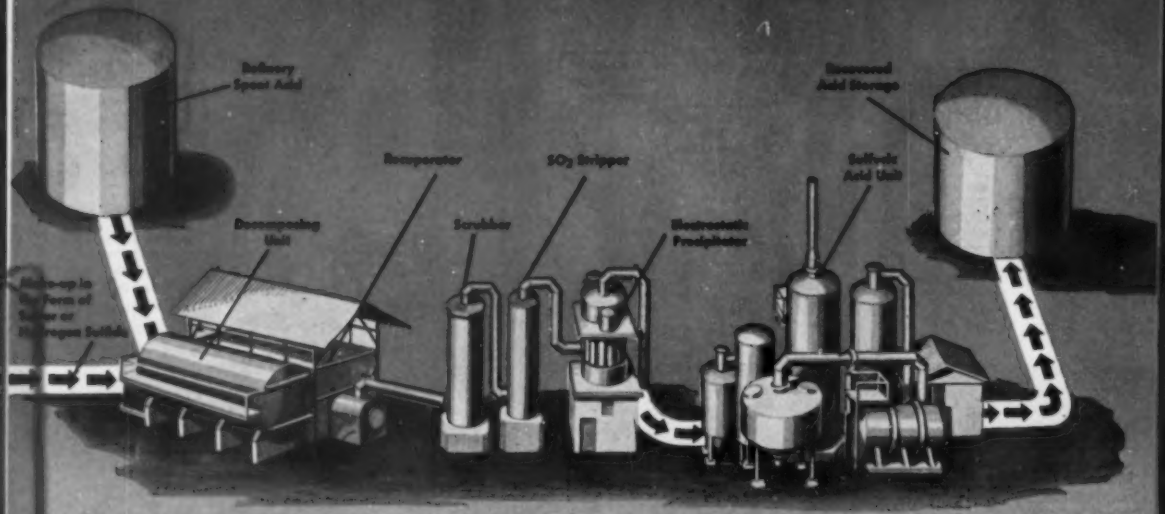
MINNEAPOLIS-HONEYWELL REGULATOR Co., *Industrial Division*, 4498 Wayne Ave., Philadelphia 44, Pa.

MINNEAPOLIS
Honeywell

Brown Instruments

CHEMICO OFFERS AN ECONOMICAL PROCESS FOR

Spent Alkylation Acid Regeneration



Due to the increased cost of brimstone and the vital need to conserve basic sulfur deposits, petroleum refiners producing high octane aviation gasoline will find it desirable to recover the sulfuric acid from their spent alkylation acid. For this purpose, Chemico offers a proven and economical process.

In this process, spent alkylation acid—now in greater supply as a result of the increased manufacture of high octane gasoline—is sprayed into a furnace maintained at a high heat with auxiliary burners. Sulfur or hydrogen sulfide may be used as fuel thereby producing SO_2 gas for the production of make-up acid.

A limited amount of other liquid acid sludges, high in hydrocarbon content, may also be added to the alkylation spent acid, thus providing fuel as well as additional acid production. The hydrocarbons are completely consumed and the acid is broken down into its components—sulfur dioxide, oxygen and water. After the water is removed, the gas is processed to fresh acid of 98% strength in a Chemico contact sulfuric acid unit. Send for additional information, stating your requirements.

CHEMICAL CONSTRUCTION CORPORATION

A UNIT OF AMERICAN CYANAMID COMPANY

488 MADISON AVENUE, NEW YORK 22, N. Y.

EUROPEAN TECHNICAL REPRESENTATIVE: CYANAMID PRODUCTS, LTD., LONDON W. C. 2, ENGLAND
CABLES: CHEMICONST, NEW YORK

Chemico plants are profitable investments

CC 211

burning in air and the structure of the hydrocarbon. The maximum velocity appears to be a function of the concentrations of the various types of carbon-hydrogen bonds in the inflammable mixture. An empirical equation is proposed which gives flame velocity as a function of the concentrations of the various types of C-H bonds and the parameters expressing the contribution of each type of C-H bond. An equation was used to calculate the flame velocity for 34 hydrocarbons and comparison is presented of the calculated and experimental values. The average difference between calculated and observed flame velocity is less than 2 percent and the calculated coefficients are in the numerical order that would be expected from other chemical considerations. The results are presented in detail in tabular form.

Viscosity of Fire-Fighting Foam. C. S. Grove, Jr., George E. Wise, Jr., William C. Marsh, and Joseph B. Gray. *Ind. Eng. Chem.*, **43** (1951), pp. 1120-2.

Fire-fighting foams are usually considered to be relatively resistant to flow. However, there is some evidence that the resistance decreases appreciably as the rate of flow increases. Few data on the subject are available. In the investigation reported, the viscosity of foam was determined for foams of various proportions of air and water, and at various total pressures and rates of shear. The purpose was to provide data that could be used for predicting pressure drops when foam is transported in pipe lines. It was found that the viscosity, calculated from a plot of friction factor versus Reynolds number, was nearly independent of the rate of flow. The viscosities of foams of the same density are the same over a wide range of pressures and ratios of air to water. The viscosity of the foam approaches that of water as the total pressure on the system is increased to 90 psig. The data are presented in tabular and graphical form.

Chemical Composition and Reactions

Composition of Fischer-Tropsch Diesel Fuel-Cobalt Catalyst. C. C. Ward, F. G. Schwartz, and N. G. Adams. *Ind. Eng. Chem.*, **43** (1951), pp. 1117-9.

A diesel fuel made by the Fischer-Tropsch process using a cobalt catalyst was analyzed as part of a program to study the relationships of composition of diesel fuel to engine performance. This particular fuel was chosen because it was a synthetic fuel and had an unusually high cetane number. It was found to be composed primarily of n-paraffins, with smaller quantities of polar compounds, alpha olefins, and some other olefins. The approximate composition was paraffins, 88 percent, polar compounds 2 percent, alpha-type olefins 1.5 percent, and internal-type olefins 8.5 percent. The work emphasizes the need for a better method of rating high-cetane-number fuels. Several of the fractions rated higher than 100 cetane number.

Materials Adsorbed at Crude Petroleum-Water Interfaces. Isolation and

SPECIFY "International"

FOR COMPLETE SERVICE AND DEPENDABILITY

You can't beat INTERNATIONAL REFINERY MIXING EQUIPMENT for the most rapid and economical blending of Gasoline, Gasoline Ethyl mixing, lubricating and fuel oil blending, as well as by-products liming, caustic and doctor treating . . . This up-to-date equipment is indispensible in cycling operations and pipe line work, and for uniformity in charging stock — mud mixing — a "natural" for research, laboratory and pilot plants.

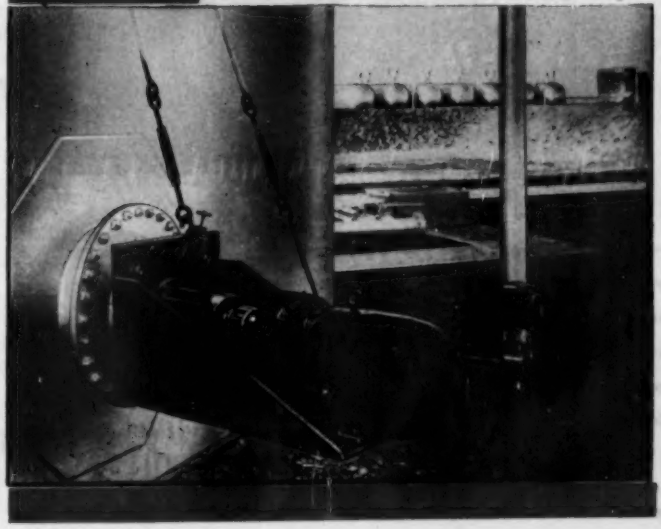
Call on INTERNATIONAL'S vast experience for assistance in solving your Mixing and Blending problems. Our Engineering staff is at your service. Remember, INTERNATIONAL builds and guarantees the equipment you need for the best possible results at the lowest possible operating cost. Write for catalog and complete information on Top Entering, Side Entrance and Portable Mixers today.

INTERNATIONAL ENGINEERING, INC.

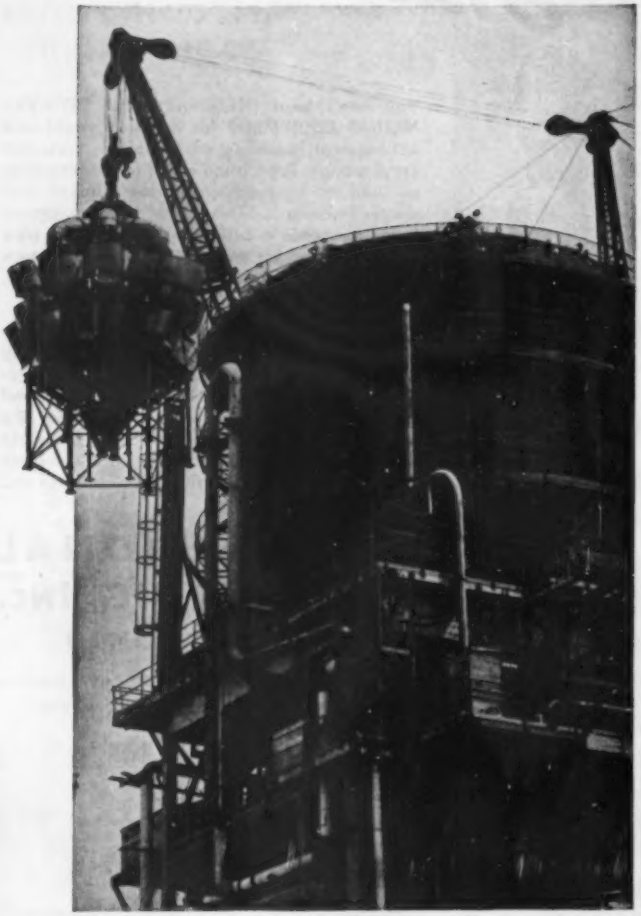
DAYTON 1, OHIO

NEW YORK • 15 Park Row • CHICAGO • 407 S. Dearborn

DISTRICT REPRESENTATIVES IN PRINCIPAL CITIES



BUELL 'GOES TO THE TOP'
in catalyst recovery



In fluid or thermofor catalytic cracking Buell recovery systems have demonstrated continuous high-efficiency performance in all the major refineries. Design information is available on the latest multi-stage collectors. Buell Engineering Company, 70 Pine Street, Suite 5070, New York 5, N. Y.

buell

Engineered Efficiency in

DUST COLLECTION

MANUFACTURING IN UNITED STATES AND CANADA FOR SHIPMENT THROUGHOUT NORTH AND SOUTH AMERICA

Science and Technology

Analysis of Normal Paraffins of High Molecular Weight. MILTON O. DENEKAS, FRANZ T. CARLSON, JOHN W. MOORE, AND CHARLES G. DODD. *Ind. Eng. Chem.*, **43** (1951), pp. 1165-9.

Film-forming and surface-active components present in crude petroleum may be responsible for many problems encountered in the production and refining of petroleum. The water-spray extraction method was used to isolate such substances from a sample of crude petroleum from the Wilcox formation in the Oklahoma City field by adsorption at an extended oil-water interface. One fraction, isolated in an amount of 1 gram per 7.5 liters of oil, was shown by chemical and physical analysis to consist of normal paraffins containing up to 70 or 80 carbon atoms. Other fractions contain surface-active material. It may be possible to isolate high molecular weight normal paraffins in this manner more economically than to synthesize them. Wax-containing films on rock surfaces are believed to affect core analysis procedures and laboratory flooding tests, as well as the recovery of petroleum from depleted reservoirs by air and possibly water drive. A bibliography of 20 references is included.

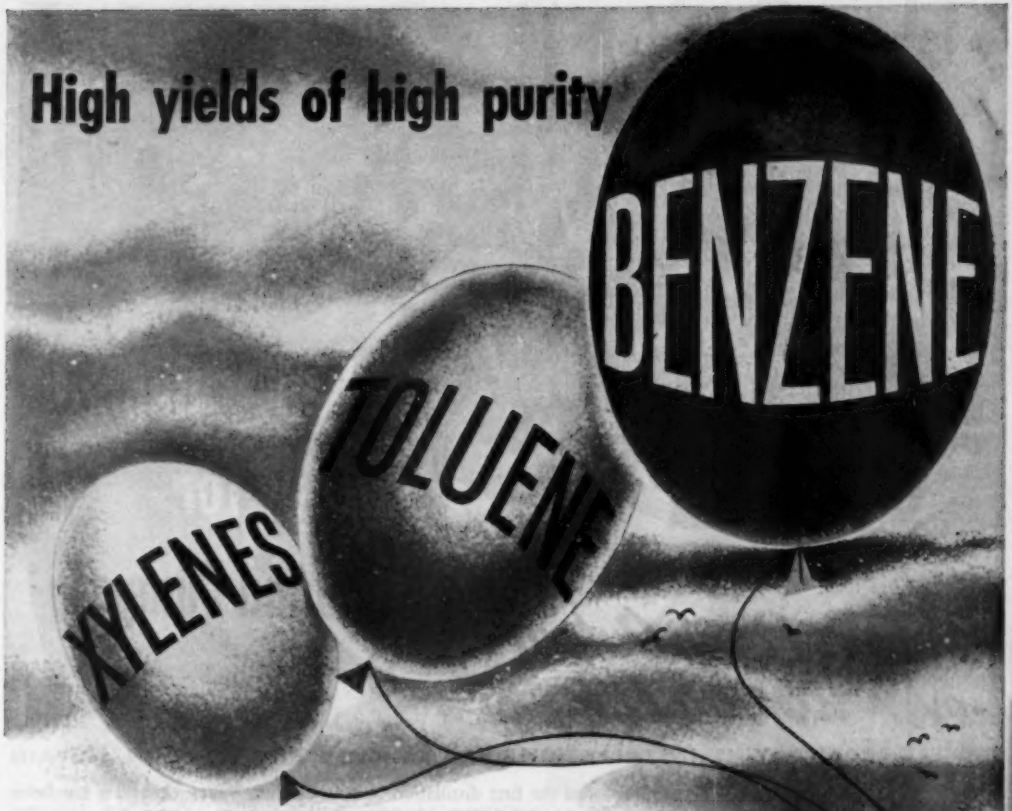
Manufacture: Processes and Plant

An Algebraic Solution of McCabe-Thiele Diagram. M. R. BEYCHOK. *Chem. Eng. Progress*, **47** (1951), pp. 265-9.

In evaluating studies of fractionating columns it is necessary to have an algebraic method of calculating individual tray efficiencies as well as sectional efficiencies. The method should lend itself to repetitive calculations and permit duplication of results. Graphical methods do not yield exactly duplicable results. The author presents an algebraic solution of the McCabe-Thiele method which lends itself to repetitive calculations and avoids drafting errors. Typical applications of the procedure are given and a bibliography of 15 references is included.

Determination of Liquid-Film Absorption Coefficients; A New Type of Column and Its Application to Problems of Absorption in Presence of Chemical Reaction. E. J. STEPHENS AND G. A. MORRIS. *Chem. Eng. Progress*, **47**, (1951), pp. 232-42.

A new type of laboratory absorption column suitable for the determination of liquid-film matter transfer coefficients is described. The apparatus will give results for physical solution similar to those obtained in packed towers. If the relative performance of the laboratory column is related to various packings for a known system it then becomes possible to predict the liquid-film coefficient for other systems with these packings by means of laboratory experiments with the columns. The advantage lies in avoiding the use of large quantities of gas and liquid for experiments on a semiplant scale. The apparatus is particularly useful when it is required to determine absorption coefficients for systems involving chemical reaction in the liquid. The column was tested by studying the absorption of chlorine from



High yields of high purity

from petroleum . . . at lowest cost

The Shell Aromatics Recovery Process meets today's needs with new economies

REFINERS planning production of aromatics from petroleum will find this Shell patented process most attractive in yields and over-all costs . . . with lowest commitment of critical construction materials.

The Shell Aromatics Recovery Process assures high-yield, selective separation of high purity benzene, toluene and xylenes from accompanying non-aromatics at low cost.

The Shell Aromatics Recovery Process is proved in full-scale refinery operation. It is available to refiners under a license from the Shell Development Company . . . together with experienced engineering service for its design and operation.

SHELL DEVELOPMENT COMPANY

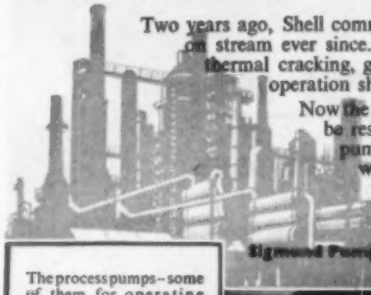
50 WEST 50TH STREET • NEW YORK 20, N. Y.

SHELL

Shell Repeat Order for Sigmund Pumps

Process Pump Output -over 20,000 H.P.

BIGGEST PROCESS PUMP INSTALLATION EVER DESIGNED AND MADE IN BRITAIN



Two years ago, Shell commissioned the first distillation unit at Cardon, Venezuela and it has been on stream ever since. The process pumps operating in this distiller — along with units for thermal cracking, gas tail, high vacuum and other sections of the refinery, which went into operation shortly afterwards, were supplied by Sigmunds.

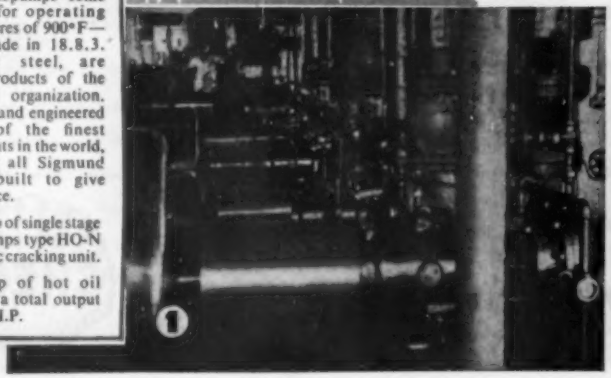
Now the second distillation unit has been put in hand, and once more Sigmund are to be responsible for the pumps. This new contract raises the total of Sigmund pumping equipment at the Cardon refinery to over 20,000 h.p., in a plant which will have an intake of crude oil in the region of 140,000 barrels a day when the additional distillation unit is completed — sufficient to provide over a third of Britain's requirements of petroleum products.

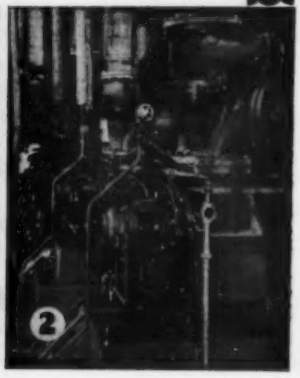
Sigmund Pumps Ltd., Terminal House, 52, Grosvenor Gardens, London, S.W.1.

The process pumps – some of them for operating temperatures of 900°F — others made in 18.8.3. stainless steel, are typical products of the Sigmund organization. Designed and engineered in one of the finest pump plants in the world, and, like all Sigmund pumps, built to give real service.

1. Group of single stage slurry pumps type HO-N in catalytic cracking unit.

2. Group of hot oil pumps of a total output of 3,000 H.P.





air into an aqueous solution containing ferrous and ferric chlorides. The effects of liquid rate, concentration of unconverted ferrous chloride, and partial pressure of chlorine in the gas were correlated. The results were found to be consistent with the assumptions that a rapid reaction takes place in a narrow zone within the liquid film, and that the rate of absorption is controlled by the rates of diffusion of the reaction products. Data are presented in detail in tabular and graphical form and a bibliography of 14 references is included.

Absorption on a Semi-works Scale. Absorption of Sulfur Dioxide in Water in a Packed Tower. D. A. Pearson, L. A. Lundberg, Frank B. West and Joseph L. McCarthy. *Chem. Eng. Progress*, **47** (1951), pp. 257-64.

The absorption of sulfur dioxide in water in a semi-works scale packed tower was studied over the commercial range of operating conditions. The tower was packed with one-inch Raschig rings. The effect of tower height and of chemical reactions between the solute and solvent were investigated. Equilibrium was closely approached in many of the runs. Because of this, the literature dealing with the equilibrium solubility of sulfur dioxide in water was studied, and the data correlated and smoothed to yield recommended equations for the equilibrium over the range 0 to 50° C. and 0 to 800 mm. of mercury pressure. Experimental data are expressed in terms of heights of transfer units. The results were found to agree with previous results taken in a tower one-tenth as tall but with end effects eliminated. The heights of transfer units as experimentally determined range from approximately those predicted by the usual correlations up to twice the values so predicted. Better agreement was obtained when the results were expressed as pseudoheights of transfer units corresponding to the pseudoequilibrium and operating lines as suggested in previous works by Vivian and Whitney. A bibliography of 30 references is included.

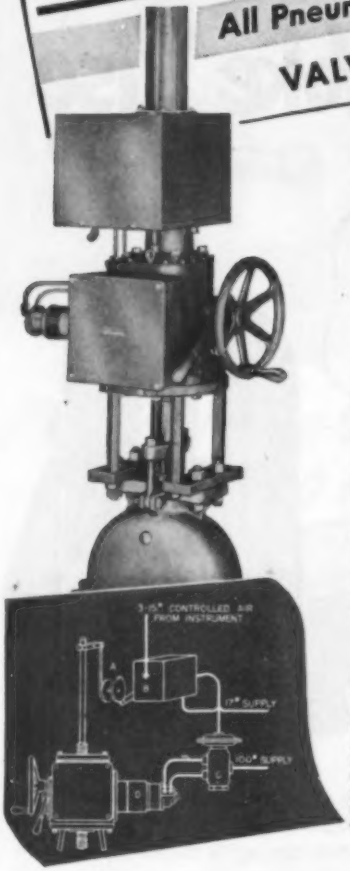
Fluidization Studies of Solid Particles. Clark O. Miller and A. K. Logwinuk. *Ind. Eng. Chem.*, **43** (1951), pp. 1220-6.

The fluidization studies reported were undertaken for particles in the 60- to 200-mesh size, using helium, carbon dioxide, air, and ethane as fluidizing media. As the term implies, "fluidization" means that the catalyst or solid behaves as a fluid. It can be transported by means of pipes or ducts, analogous to a true liquid. An important advantage of such a system is the improved heat transfer and temperature distribution which results from the extremely turbulent nature of the fluo-solid phase. Fluidization can occur in either a dilute or a dense phase. The dense phase is the type used in reactors and standpipes of fluid catalytic petroleum equipment. The first problem in the present investigation was to determine the mass velocity required to initiate movement. This is termed the "critical mass velocity." This is defined and related to the fluid and solids properties by an equation that is given. This mass velocity was found to be independent of weight or bed height for a given material. Heat transfer

The Handy Durable
RIDGID
Bench Yoke Vise
It's got what you need for easy work
● You save time and effort with this more-for-your-money RIDGID Bench Vise. Right where you need 'em are its intregral pipe rest and benders that won't flatten pipe—and heat-treated tool-steel LonGrip jaws mean you don't have to be so fussy with polished pipe. Special malleable frame, extra durable. 8 sizes to 6″ pipe, bench, post, stand and Tristand models, yoke and chain. Order from your Supply House.
RIDGID
★ Work-Saver Pipe Tools ★

NEW! Revolutionary Rotomotor

All Pneumatic—Heavy Duty VALVE OPERATOR



Never before has such an operator for ***throttling control*** service been offered to the trade. Rotomotor is a compact, easily mounted, easily serviced, all-pneumatic control mechanism for positioning large valves, dampers, and other heavy duty control elements. Refineries are fast adopting Rotomotor for fluid catalyst valves and high differential back pressure valves. Using the ***safety*** and ***economy*** of air at ordinary 90 to 100 psi, a reversible motor drives the gear train repositioning the screw stem to accuracies of 1/500th part of total stem travel. Stem is ***self-locking;*** can't move in case of air failure. Continuously connected handwheel eliminates need for expensive by-pass systems.

Rotomotor is capable of handling thrust loads up to 60,000 pounds with stem travels up to 36". Yet it responds to instrument air pressure change as small as .025 psi... Unexcelled for ***sensitivity*** and ***stability***.

Here is how it works:

POSITIONING DEVICE (B) determines *actual* valve stem position by means of tape and cam connection (A) and *desired* stem position by air impulse from control instrument. Corrected output air pressure from (B) then is fed to AUXILIARY PILOT (C) which ports main air supply to PNEUMATIC MOTOR (D) driving gear box clockwise or counterclockwise repositioning stem and completing pneumatic control loop.

SEE THE ROTOMOTOR AT THE ISA SHOW

Don't miss this feature attraction of the Conoflow Exhibit, Booths 126-128, in Houston September 10-14.

New Bulletin PR mailed on request.

Cono-Controls

CONOFLOW CORPORATION

2100 ARCH STREET • PHILADELPHIA 3, PENNA.

studies from a hot dense fluid bed to vertical cool tube were made. Three gases and two solids were studied. Coefficients of 40 to 200 Btu./(hour) (square foot) (° F.) were observed. A correlation of the data is presented. Qualitative observations of electrostatic charges encountered in a fluidized solid system are discussed. A bibliography of 10 references is included.

The Fluidized Bed. Transition State in the Vertical Pneumatic Transport of Particles. RICHARD H. WILHELM AND STEPHEN VALENTINE. *Ind. Eng. Chem.*, **43**, (1951), pp. 1199-1203.

The investigation was concerned with an experimental study of the behavior of a stream of solid particles introduced into a rising stream of gas. Suspended particles may form dense-phase fluidized beds, such as have been important industrially. Under some conditions, however, a stable bed is not formed, but the particles are transported by the suspending stream. It is desirable to know when fluidized beds are formed and when the particles will be carried away pneumatically. Experiments were conducted in a four-inch vertical, unobstructed tube with three sizes of clay spheres varying between approximately ¼ to ⅜-inch diameter. It was found that fluidized beds were formed as the direction of the motion of the particles changed from cocurrent to countercurrent, relative to the rising air stream.

Heat Transfer in Fluidization Beds—Part II. O. P. AGARWAL AND J. ANDERSON STORROW. *Chem. and Ind.*, April 28, 1951, No. 17, pp. 321-4.

Experiments were carried out on the heat transfer from a heated wall to air flowing through a fluidized bed, and using various materials as the suspended particles of the bed. Steam was passed through the jacket surrounding the tube in which the fluidized material was contained. Curves for heating materials were found to be continuous and no not suggest any abrupt change in h as G is increased to suggest that heat transfer alters the cause of fluidization. The values of the heat transfer coefficient h are a function of particle size. The mass of material in the fluidized bed seems to have little effect on the surface conductance at high air rates. The data are presented in graphical form in several plots.

Acid Treatment of Shale Gasoline. Part 1. Hydrolysis of the Acid Sludge. R. C. MATHEWS AND G. E. MAPSTONE. *Jour. Inst. of Petroleum*, **37** (1951), pp. 147-57.

The description of the acid-treatment process has been presented elsewhere. This article is concerned with the hydrolysis of the acid-sludges obtained. It was found that the quantity of the acid extracted by hydrolysis of the acid sludge is independent of the proportion of water used. The total tar content, both soluble and insoluble in the hydrolysed acid, was found to decrease with increasing acid concentrations above six normal. Also the specific gravity of the hydrolysed acid and of the insoluble tar increased with increasing acid strength. The hydrolysed acid precipitated tars

spontaneously. These tars were found to be soluble in a number of solvents. However, on standing for a few weeks the tars decomposed with evolution of foul-smelling gases, and were then only sparingly soluble in the solvents. The hydrolysed acid appreciably corrodes mild steel pipe at temperatures above 200° F. A maximum rate of corrosion was obtained with approximately 7N acid.

Products: Properties, Utilization and Analysis

Modification of Lamp Method for Sulfur in Naphthalene. J. J. TIGHE, J. S. MCNULTY, AND E. J. CENTER. *Analytical Chem.*, **23** (1951), pp. 669-70.

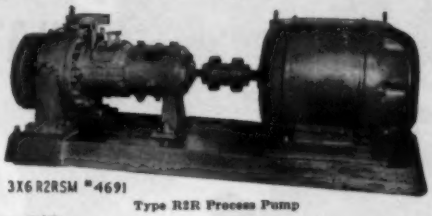
The ASTM lamp method is applicable to the determination of sulfur in any liquid that can be burned completely in a wick lamp, as for example, in gasoline or kerosene. An attempt has been made to apply the method to solid materials such as naphthalene dissolved in solvents. The difficulty has been the deposition of naphthalene on the cooler portion of the wick and the difficulty in obtaining a sootless flame. The authors describe the application of the infrared lamp to overcome these troubles. The infrared lamp was directed against a sample container and wick holder, thus maintaining a higher temperature and combustion in a reasonable length of time. Typical examples of the results obtained are presented.

Properties of High Boiling Petroleum Products. Physical and Chemical Characterization Studies with Relation to Polynuclear Aromatic Components. G. G. WANLESS, L. T. EBY, AND JOHN REHNER, JR. *Analytical Chem.*, **23** (1951), pp. 563-71.

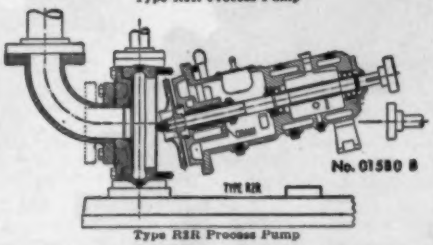
Many high boiling petroleum products, particularly those produced by cracking, contain polynuclear aromatic hydrocarbons in varying concentrations. These hydrocarbons influence the properties of the product. The usual methods for determining petroleum aromaticity, based on simple determinations of refractive index, aniline point, density, boiling point, or some combination of these properties, do not meet current needs. The authors developed several physical and chemical methods. One of these is a combination procedure based on the refractometry of chromatographic fractions. Another is based on the ultraviolet absorption spectra. In a third, the polynuclear aromatic components were extracted from oils by means of aqueous caffeine solution. The extract was spectrometrically analyzed. The fourth procedure was concerned with characterizing components having an anthracene nucleus, and employing a Diels-Alder type reaction of the oil with maleic anhydride. A fifth procedure had to do with use of oxidizing agents such as lead tetraacetate and osmium tetroxide. Applications of the methods were made in studying refinery processes such as thermal and catalytic cracking. They are also useful for examining the product behavior of tars, lubricating oils, asphalts, waxes, and residuals.

DEAN BROTHERS PUMPS INC.

Type R2R Centrifugal Process Pumps



Type R2R Process Pump



Type R2R Process Pump

DISASSEMBLY: The Type R2R process pumps can be disassembled without disconnecting the suction and discharge piping. By first removing the spacer from the spacer type coupling, and unbolting the casing from the cradle the entire cradle and complete rotating element can be removed without disturbing the suction and discharge piping.

OPERATING RANGE: Type R2R. Heavy duty, process pumps are available in eighteen different sizes, enabling our engineers to furnish units specially designed and constructed for the particular work to be performed.
Capacities: 50 to 2000 Gallons per minute. Heads: Up to 400'. Speeds: 900 RPM to 4000 RPM.

BUILDERS OF OUTSTANDING PUMPS SINCE 1869

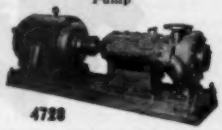
CENTRIFUGAL and RECIPROCATING PUMPS

Close Coupled Centrifugal Pump

Horizontal, Single Style, Double Acting, Piston Type, Close Clearance Pump. Designed to handle volatile liquids

Pedestal Mounted Centrifugal Pump

Horizontal, Duplex, Double Acting, Side Pot, Piston Type, Oil Bath Power Pump



Double Pedestal Bearing Centrifugal Pump

Durable Duplex Packed Piston Pattern Steam Pump, Side Pot Type

ESTABLISHED 1869

DEAN BROTHERS PUMPS INC.

INDIANAPOLIS IND.

323 W TENTH ST.

Branch Offices: NEW YORK, N. Y., HOUSTON, TEXAS

Representatives in Principal Cities

WARREN'S Stabilized NATURAL GASOLINE Geared TO TODAY'S NEEDS for

QUICK-STARTING

CARBON-FREE

KNOCKLESS

MOTOR

FUEL

NATURAL GASOLINE
Propane
Iso-Butane
Butane
Iso-Pentane
Normal Pentane
Hexane
Heptane
Heavy Naphtha
STA-VOL-ENE

Modern traffic, industry and agriculture call for greater speed, pep, power and performance in motor fuel. Warren has the answer — it's Stabilized Natural Gasoline and Butane and their vital elements of high octane, constant uniformity, correct volatility. Before you contract, contact your nearest Warren office. Warren has ample production, adequate storage and shipping facilities to meet your needs.

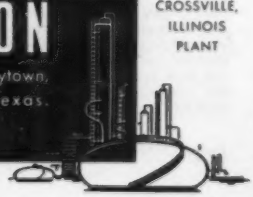
WARREN PETROLEUM CORPORATION

Producers, Manufacturers, Exporters and Marketers

Export Terminals: Corpus Christi, Port Arthur, Baytown, Texas City, and Norsworthy, Houston, Texas.

TULSA 2, OKLAHOMA CABLE ADDRESSES: Stavolene, Warren

WARREN'S CROSSVILLE, ILLINOIS PLANT



Crude Oil, Natural Gasoline and Liquefied Petroleum Products

Digest of Recent U. S. PATENTS Pertaining to PETROLEUM REFINING

Compiled by HEINZ HEINEMANN

(From the Official Gazette, April 17, 24 and May 1 and 8, 1951)

CRACKING AND REFORMING

U.S.P. 2,548,860. Hydrocarbon Conversion Process With the Use of a Grainy Silica-Alumina Type Catalyst. G. R. Bond, Jr., to Houdry Process Corporation.

Higher boiling hydrocarbons are cracked in the presence of a catalyst prepared by precipitation of silica and alumina from an aqueous medium containing silicon and aluminum compounds under conditions to form a grainy precipitate. The soluble compounds shall be present in sufficient concentrations in the aqueous medium to furnish silica and alumina in a product concentration of at least 150 grams per liter of total reaction mass. The precipitation is effected at a pH of 2-10 in the presence of added acidic material. Gasoline is produced.

U.S.P. 2,549,518. Combined Selective Adsorption-Catalytic Cracking Process. S. F. Perry to Standard Oil Development Company.

A petroleum feed oil is segregated into a fraction boiling in the gas oil range and a fraction boiling in the lubricating oil range. The first named fraction is catalytically cracked to produce a cracked gasoline. The cracking catalyst employed is regenerated and contacted with the second named petroleum fraction under conditions to adsorb the more aromatic type constituents on this catalyst. The cracking catalyst separated from the oil and containing the adsorbed constituents is then recycled to the cracking zone. High quality lubricating oil and high quality cracked gasoline are produced by this process.

U.S.P. 2,550,290. Catalytic Cracking of Hydrocarbons. H. L. Pelzer and K. M. Watson to Sinclair Refining Company.

In the catalytic cracking of hydrocarbons, the virgin charge oil and the recycle stock are separately cracked in separate reactors. The heavier and the lighter recycle fractions obtained from the effluent vapors from the cracking of the virgin stock are also subjected to different cracking conditions. Catalyst used in the cracking of the virgin charge stock is employed in the cracking of the recycle stocks.

U.S.P. 2,550,374. Method for Handling Suspensions. J. S. Palmer to Standard Oil Development Company.

A method is claimed for maintaining a finely divided solid in suspension in a gasiform fluid, e.g. in the cracking of petroleum fractions in the presence of a powdered catalyst.

U.S.P. 2,550,531. Reforming Process and Catalyst Therefor. F. G. Ciapetta to The Atlantic Refining Company.

A gasoline or kerosine petroleum distillate fraction is contacted at reforming conditions in the presence of hydrogen with a catalyst comprising a cracking component and Pt or Pd, e.g. in amounts of 0.01-2.5 percent of the final catalyst. The cracking component comprises silica and alumina and has been treated to obtain a surface area of 10-65 square meters per gram. The anti-knock value of the distillate is increased by this treatment, due to dehydrogenation of hydroaromatics and isomerization of n-paraffins. For example, the gasoline fraction is contacted with the catalyst at a temperature of 600-1000° F., a pressure of 100-1000 psi., and an hourly space velocity of 0.1-10 in the presence of 1-20 mols of hydrogen per mol of hydrocarbon. The catalyst can be prepared by heating a synthetic silica-alumina cracking component at temperatures of 1600-1800° F., or at 900-1400° F., in the presence of steam, until its surface area is reduced to about 10-65 square meters per gram. Pt and Pd is then composited with this product.

U.S.P. 2,550,727. Method of Catalytic Cracking of Hydrocarbons Utilizing a Moving Catalyst Bed. H. G. Shimp to Houdry Process Corporation.

In a hydrocarbon cracking system for producing high octane gasoline from higher boiling hydrocarbons with continuous regeneration and recycling of the granular catalyst moving downwardly as a non-turbulent bed, a constant amount of coke deposited on the catalyst is maintained in the cracking zone and high yields of the gasoline are obtained by establishing relative rates of flow of streams of catalyst and of hydrocarbon material through the cracking zone. The heat capacity of the introduced hydrocarbon stream shall be greater than that of the introduced catalyst stream but less than twice as great. Some other details are claimed.

U.S.P. 2,551,580. Acid-Treated Clay Catalyst for Cracking Hydrocarbons. G. R. Bond, Jr., to Houdry Process Corporation.

Higher boiling hydrocarbons are cracked to form gasoline in the presence of a pelleted catalyst composed of an acid activated sub-bentonite montmorillonite clay residue comprising 1-3 percent alumina and impregnated with alumina. The special process for preparing such a catalyst which exhibits low coke forming characteristics, is also claimed.

REFINING

U.S.P. 2,549,063. Liquid Separation Method and Apparatus. L. V. H. De-Haven to Bowser, Inc.

An emulsion, such as is formed in the use of lubricating oils in high pressure reciprocating steam engines, is passed through a cake of filter aid material. The emulsion liquids are separated. A portion of the separated continuous phase liquid is continuously circulated through the cake.

U.S.P. 2,549,372. Extractive Fractionation Process. L. C. Fetterly to Shell Development Company.

A mixture of hydrocarbons containing a fraction A of straight-chain hydrocarbons and a fraction B of non-straight-chain hydrocarbons is treated with urea. The crystalline complexes formed of the A hydrocarbons and urea are separated. At least part of these complexes is recycled to enrich additional quantities of the original mixture prior to the urea treatment. The enriched mixture of complexes then obtained forms a more porous filter cake.

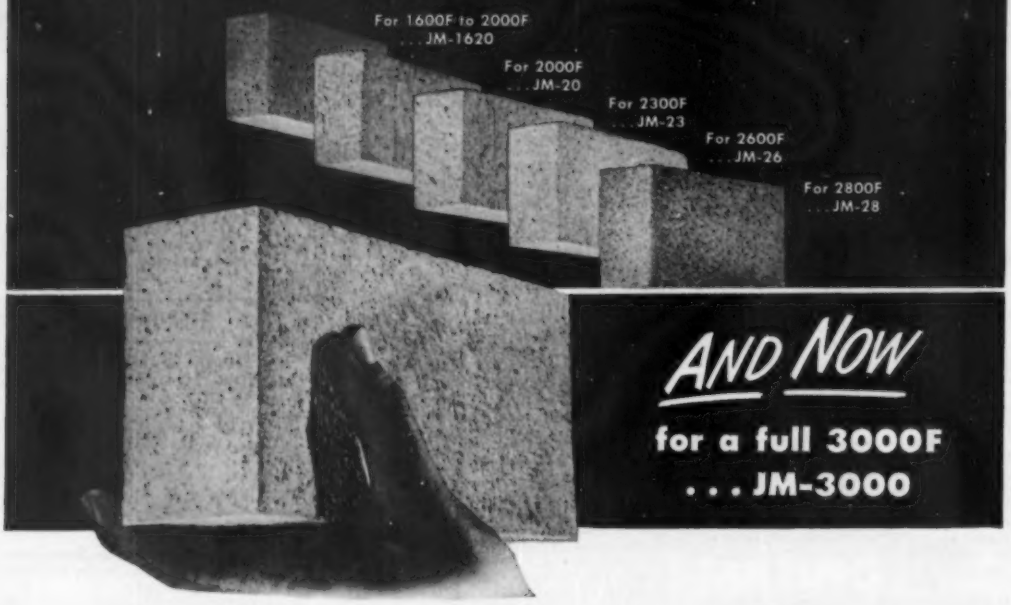
U.S.P. 2,549,434-9. Processes for Breaking Petroleum Emulsions. M. De-Groots, A. F. Wirtel, and O. H. Pettingill to Petrolite Corporation, Ltd.

A demulsifier for breaking petroleum emulsions includes at least one cogeneric mixture of a homologous series of glycol ethers of beta-terpineol obtained by various methods from alpha- or beta-terpineol, ethylene oxide, and propylene oxide. According to U.S.P. 2,549,438-9 glycide can be used together with these ingredients in the preparation of the cogeneric mixture.

U.S.P. 2,545,555. Recovery of Ammonia from Butadiene-Ammonia Mixture. S. W. Wilson to Standard Oil Development Company.

A butadiene ammonia mixture, obtained by desorbing an ammoniacal cuprous salt solution of the butadiene in the separation of butadiene from other hydrocarbons, is scrubbed in the gas phase with an aqueous alkaline solution having a pH above 8 of a phenolic compound. The aqueous phenolic solution is heated in a stripping column to drive off ammonia. The aqueous bottoms are then recycled to the scrubber. The phenolic

MEET the family of Johns-Manville Insulating Fire Brick . .



HERE IS AN OUTSTANDING FAMILY of insulating fire brick for back-up or exposed use . . . the only family of its kind . . . that gives you a complete range . . . a *quick heating* insulating fire brick for every purpose.

By taking advantage of the quick heating characteristics of these insulating fire brick, you'll benefit through important savings in fuel because of the quicker rise to proper operating temperature in the furnace. This is a result of the low heat storage capacity and low thermal conductivity characteristics of the brick. These factors are especially important where furnaces are being intermittently operated.

The same materials can also be obtained in large size units as Johns-Manville Insulating Fireblok. This product has many advantages over the smaller size fire brick, from both a construction and stability standpoint. They can be quickly applied because they are easy to cut and fit. J-M Insulating Fireblok provide additional heat savings because they reduce the number of joints, and require less mortar for bonding.

Why not have a Johns-Manville insulation expert call to tell you more about ways in which you can save by using these insulations in your furnaces. Write Johns-Manville, Box 290, New York 16, N. Y. for further information.

	JM-1620	JM-20	JM-23	JM-26	JM-28	JM-3000
Densities, lb per cu ft	29	35	42	48	58	63-67
Transverse Strengths, psi	60	80	120	125	120	200
Cold Crushing Strengths, psi	70	115	170	190	150	400
Linear Shrinkage,† percent	0.0 at 2000 F	0.0 at 2000 F	0.3 at 2300 F	1.0 at 2600 F	4.0 at 2800 F	0.8 at 3000 F
Reversible Thermal Expansion, percent	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F	0.5—0.6 at 2000 F
Conductivity* at Mean Temperatures						
500 F	0.77	0.97	1.51	1.92	2.00	3.10
1000 F	1.02	1.22	1.91	2.32	2.50	3.30
1500 F	1.27	1.47	2.31	2.52	3.00	3.35
2000 F	—	1.72	2.70	2.82	3.50	3.60
Recommended Service						
Back up	2000 F	2000 F	2300 F	2600 F	2800 F	3000 F
Exposed	1600 F	2000 F	2300 F	2600 F	2800 F	3000 F

† *24-hr simulative service panel test for JM-3000, 24-hr soaking period for other brick.*

* *Conductivity is expressed in Btu in. per sq ft per F per hour at the designated mean temperatures.*

Note: Above tests are in accordance with A.S.T.M. tentative standards.

Johns-Manville First in INSULATIONS

compound employed can be a tertiary butyl catechol, catechol, hydroquinone, or pyrogallol. The formation of butadiene polymers in the recovery of ammonia is inhibited by this method.

U.S.P. 2,549,586. Separation of Hydrocarbons with Keto Esters. T. W. Evans and R. C. Morris to Shell Development Company.

Diolefins, such as butadiene, are separated from a hydrocarbon mixture containing them and more saturated hydrocarbons of the same number of C atoms, such as butylenes, by contacting the mixture with liquid methyl acetoacetate. The diolefin is selectively dissolved.

U.S.P. 2,549,968. Means and Method for Selective Low-Pressure Desorption of Liquids. K. H. Hachmuth to Phillips Petroleum Company.

Details are claimed of a method of selective recovery of gases, such as the separation of hydrogen from methane.

U.S.P. 2,550,432. Process for Recovery of Hydrocarbon Oil from Shale. W. I. Thompson to Standard Oil Development Company.

In the recovery of hydrocarbon oil from oil-bearing minerals, such as tar sands and shale, by distillation, a fluidized bed of the solids is employed. Details are claimed.

U.S.P. 2,550,955. Adsorption Process and Apparatus. C. H. O. Berg to Union Oil Company of California.

In the continuous separation of a gaseous mixture by selective adsorption, e.g., in the separation of ethylene from a gaseous mixture, this mixture is simultaneously contacted with a moving bed of granular solid adsorbent flowing downwardly through a multiplicity of separate adsorption zones. The less readily adsorbable constituents of the mixture are removed from each of these zones. The rich adsorbent from each zone is flowed to a desorption zone for desorbing the more readily adsorbable constituents of the gas mixture.

U.S.P. 2,550,981. Method of Inhibiting Fogs in Hydrocarbon Products. W. F. Eberz to Petrolite Corporation, Ltd.

A hydrocarbon product containing dissolved water up to saturation is treated with minute amounts of surface-active-agent-forming organic acidic and anhydrous alkaline materials to form a surface-active agent in situ in the hydrocarbon product. The formation of fog on cooling this product is prevented by the presence of this surface-active agent.

U.S.P. 2,550,982. Fog Inhibited Hydrocarbon Product and Method. W. F. Eberz to Petrolite Corporation, Ltd.

The method of this patent is closely related to that of U.S.P. 2,550,981. A minute amount of the surface-active agent, e.g. a high molal organic sulfonate, is dissolved in the hydrocarbon product containing dissolved water, for example by injection into the flowing stream of this product.

U.S.P. 2,551,912. Azeotropic Distillation of Naphthalenes. J. W. Teter to Sinclair Refining Company.

Naphthalene and various lower alkyl-

GET
Proper Drainage!
STORAGE WATER HEATER
STRAINER
3
2
1
STRAINER
Strong 80 Series Trap (1) with Strong Thermal Air Valve By-Pass (2) insures quick drainage of accumulated condensate and rapid starting. Strong 70 Series Trap (3) drains inlet line, maintaining dry steam at temperature regulating valve.

PROBLEM: Condensate accumulates in coils due to lack of pressure when thermostatic regulating valve is throttling or closed. ***Improper drainage and water hammer result when thermostatic valve opens.***

SOLUTION: ***Drain coils fast.*** **Use trap with four to eight times capacity of actual steam condensate rate. For medium or high pressures, either open or inverted bucket traps are suitable.** ***Use open bucket traps for low pressures.***

Completeness of the Strong trap line enables our engineers to recommend exactly the type or size you need—open or inverted bucket, closed float, float-and-thermostatic (blast), etc., forged, welded, cast or semi-steel construction. Bring your drainage problems to us for solution. Send for Strong Trap Catalog No. 68-R today for complete details of *all* Strong traps.

Strong 80 Series Trap for medium or high pressures.

Strong 30 Series Trap for high, medium or low pressures.

STRONG, CARLISLE & HAMMOND COMPANY

1392 WEST 3rd Street
Cleveland 13, Ohio

† Armco Metl Reg. Trade Mark

OTHER STRONG STEAM SPECIALTIES

Reducing Valve | 70 Series Trap | Strainer

STRONG

R·P&C
VALVES

NO. 6656
Forged
Steel
Gate Valve

Here is a Premium Valve
that is NOT premium priced

CHECK THESE DESIRABLE FEATURES:

- Bolted bonnet construction
- Heat-treated and hard chrome plated stainless steel wedge
- Stainless steel gland eye-bolts and nuts
- Two-piece gland and follower
- Tongue and groove bonnet joint

It's well designed. It's low priced in its field.
See your R-P & C distributor or write nearest R-P & C district office.

ACCO
R-P & C VALVE DIVISION
AMERICAN CHAIN & CABLE

"Intrinsically Better"
READING-PRATT & CADY VALVES

Patents

ated naphthalenes are separated from mixtures containing the same and non-aromatic hydrocarbons by azeotropically distilling the mixture with benzonitrile.

U.S.P. 2,552,198. Extraction of Hydrocarbon Types. B. J. Mayland and E. E. White to Phillips Petroleum Company.

A mixture of paraffins and olefins is subjected to liquid-liquid extraction at a temperature of 50-100° F. with two solvents immiscible with one another, the one solvent dissolving the olefins, and the other the paraffins. The one of these solvents is betahydroxypropionitrile and the other is a C_5-C_{12} aliphatic olefin, e.g. caprylene.

U.S.P. 2,552 351. Method of Treating Unstable Cracked Hydrocarbons. B. R. Strickland and B. M. Vanderbilt to Standard Oil Development Company.

A hydrocarbon fraction is emulsified with water. The resulting emulsion is either subjected to elevated temperature or treated with a suitable catalyst suitable for converting gum forming components of the fraction under treatment into higher boiling components. After breaking the emulsion, the higher boiling constituents formed can be removed. A high quality motor fuel can thus be obtained.

U.S.P. 2,552,451. Fractionation of Low Molecular Weight Component Mixtures. J. A. Patterson to Standard Oil Development Company.

Details of a process are claimed for fractionating a low mol wt., normally gaseous C_1-C_4 hydrocarbon mixture employing at least two diminishing pressure distillation zones.

HYDROGENATION, DEHYDROGENATION, AROMATIZATION

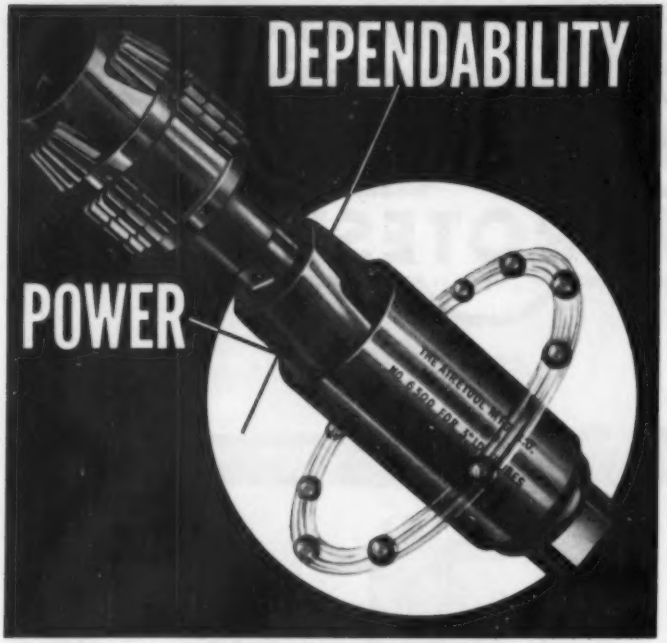
U.S.P. 2,549,111. Combination Synthesis of Hydrocarbons and Organic Carbonyl Compounds. A. J. Millendorf, E. A. Naragon, and J. H. Vergilio to The Texas Company.

In a Fischer-Tropsch synthesis, a mixed, normally gaseous fraction of the effluent stream containing gaseous olefins is separated. The proportion of H_2 to CO with respect to the olefin content of this gaseous fraction is adjusted by subjecting this fraction to water-gas shift reaction conditions at an elevated temperature such that predetermined proportions of contained H_2 and CO_2 formed in the synthesis operation are converted into CO and H_2O vapor, which is removed. The thus treated gaseous mixture is then contacted with a carbonylation catalyst containing a metal of the iron group at a pressure of 250-1000 psi. and a temperature of 100-350° F. to effect direct carbonylation of the olefins.

U.S.P. 2,552,308. Low-Pressure Hydrocarbon Synthesis Process. F. J. Buchmann and A. Voorhies, Jr., to Standard Oil Development Company.

A CO/H_2 synthesis gas mixutre is contacted under synthesis conditions comprising pressures of 50-100 psig. with a dense fluidized catalyst compris-

NON-LUBRICATED
VAPOR-TIGHT PLUG VALVE
KEROTEST
GENERAL
TWIN SEAL
Operates in 1¼ turns
NO! NO! No Lubrication
Retracting seats can't score walls
Facings as specified
Shuts off VAPOR TIGHT
235 to 5,000 P.S.I. Working Pressures
Easy to Remove this Plate to Change Seating Slips
KEROTEST
KEROTEST MANUFACTURING COMPANY
2525 LIBERTY AVENUE • PITTSBURGH 22, PA.
LOS ANGELES • CHICAGO • CHARLESTON • ODESSA • TULSA • HOUSTON • NEW YORK
ST. LOUIS • RICHMOND • TOLEDO • BALTIMORE



no tube cleaner is better than its motor

AIRETOOL ball bearing motors OUTLAST all others

AIRETOOL Motors are noted for their rugged dependability. When the going is rough—they don't break down or burn out. They make any tough job easy. The new AIRETOOL "6000" series features ball bearing thrust that reduces friction and transmits the necessary power and speed you need for a good job. They can be used with a variety of cleaning heads for any type of straight tube cleaning. Maintenance is simple. Because of their slip fit construction, you can take all AIRETOOL motors apart and put them back together right on the job without special tools. Bulletin 49 tells you all about them. To obtain your copy write immediately to The AIRETOOL Mfg. Co., 316 S. Center St., Springfield, Ohio.

BRANCH OFFICES:
NEW YORK • PHILADELPHIA • CHICAGO
HOUSTON • BATON ROUGE • TULSA

There's an AIRETOOL Tube Cleaner and Tube Expander for every Type of Tubular Construction

ing an activated carbon support carrying iron promoted with 0.4-1.0 percent (by weight of the total catalyst) of an alkali metal promoter. Normally liquid hydrocarbons of high olefin content are obtained.

U.S.P. 2,552,347. Hydrocarbon Synthesis. M. A. Segura to Standard Oil Development Company.

A CO/H_2 synthesis gas mixture is contacted at synthesis conditions with a catalyst consisting of a major proportion of iron, 2-8 percent of vanadium, and a minor proportion of a K or Na oxide, carbonate, chloride, or fluoride. This minor additive promotes the selectivity of the catalyst toward formation of normally liquid hydrocarbons, while the vanadium depresses the carbonization tendency.

U.S.P. 2,552,422. Hydrocarbon Synthesis. B. G. Gillespie to Standard Oil Development Company.

A CO/H_2 synthesis gas mixture is contacted at synthesis conditions with a fluidized mass of hydrogen-reduced iron oxide discrete particles, each containing finely divided carbon uniformly distributed, and an alkali metal promoter. The catalyst can be prepared by thoroughly mixing red iron oxide powder with 2-10 percent powdered carbon, incorporating the promoter and reducing the iron oxide with H_2 at temperatures up to 900° F., sintering the resulting mixture in a reducing atmosphere, and grinding the product.

ALKYLATION

U.S.P. 2,550,413. Alkylation Process. A. Gislou to Comp. Francaise de Raffinage (Soc. anon.), Paris.

Details are claimed of a method for alkylating benzene in the presence of a Friedel-Crafts type catalyst with a high yield of monoalkylate.

U.S.P. 2,550,769. Alkylating Thiophene With Alkyl Sulfate Catalyst. P. D. Caesar and P. G. Waldo to Socony-Vacuum Oil Company, Inc.

Thiophene or alkyl thiophenes are alkylated with an alkylating agent, such as isobutylene or isoamylene, in the presence of an alkyl sulfate with not more than 8 C atoms in the alkyl chain as the sole catalyst.

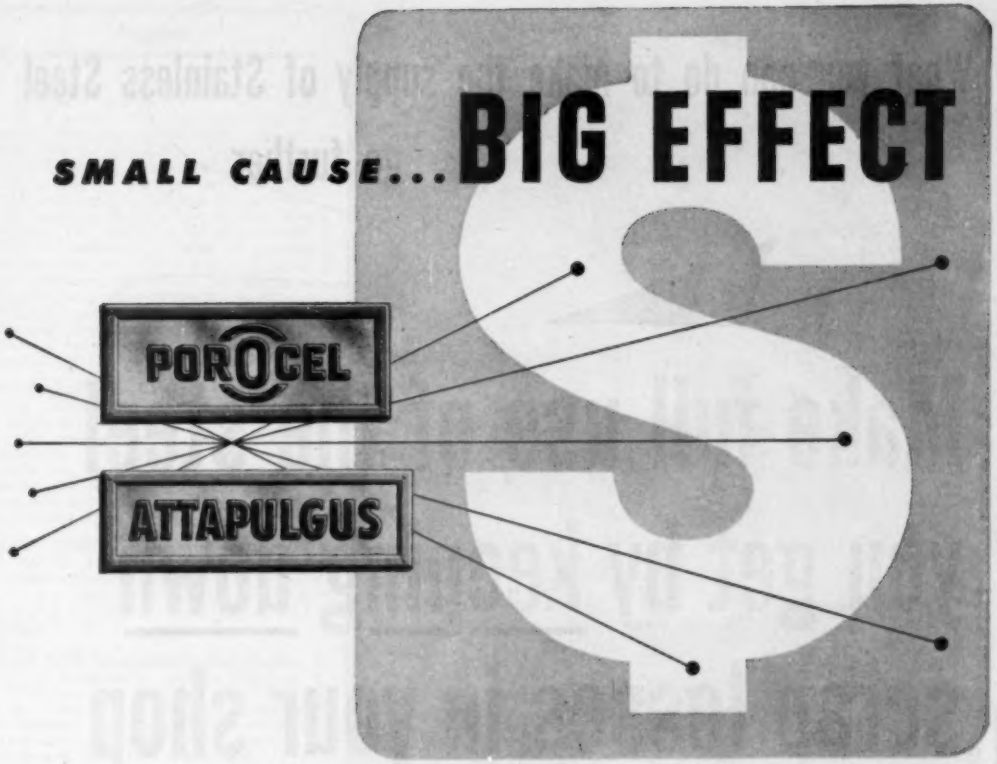
POLYMERIZATION AND CONVERSION

U.S.P. 2,548,883. Process of Removing Carbon from Catalyst. E. V. Harlow to Koppers Company, Inc.

In a catalytic process with regeneration of spent catalyst, the operating conditions are changed near the end of the conversion step in such a manner as to effect an increased deposition of carbon on the catalyst. Regeneration of the catalyst is effected when the amount of deposited carbon is sufficient to supply by combustion all the heat required for the regeneration.

U.S.P. 2,548,912. Process of and Apparatus for Converting Hydrocarbon

SMALL CAUSE... BIG EFFECT



Here's an interesting case of small cause—big effect! "Small cause" is the inexpensiveness of Attapulgus Fullers Earths and Porocel Activated Bauxites. "Big effect" is the large number and intrinsic value of jobs these materials do for petroleum refiners.

From the lightest hydrocarbons down to the heaviest lube and wax fractions, many of the finished products have received treatment by these sorptive minerals somewhere along the line. Odors, colors, tastes, moisture, acids, sulfur, fluorides and unsaturates are removed or converted; various reactions are catalyzed.

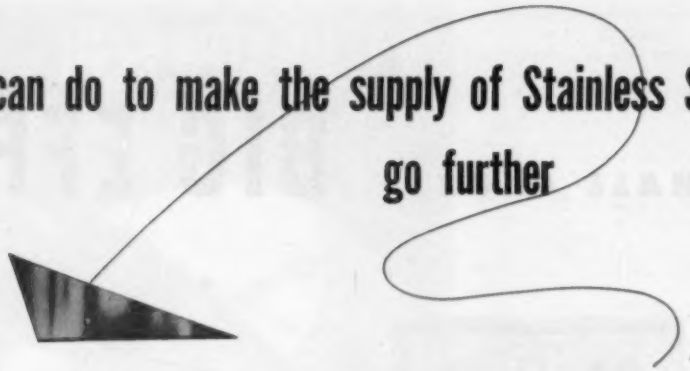
Most important, all these applications pay off. Attapulgus and Porocel adsorbents cost as little as one cent a pound. But each pound, properly applied to petroleum stocks, increases the value of these stocks by at least one dollar—a return of 100 to 1.

So let's get together on your plans to improve quality, expand output, or both. You know a lot about the techniques involved in these processes; our engineers have made many important contributions to adsorbent technology. A blending of these two funds of knowledge should produce optimum results.

ATTAPULGUS CLAY COMPANY *Fullers Earth* · **POROCEL** CORPORATION *Activated Bauxites*

Dept. W, 210 West Washington Square, Philadelphia 5, Pa.

What you can do to make the supply of Stainless Steel go further



Make full use of the steel you get by keeping down scrap losses in your shop

Keep these points in mind, too, when you order Stainless

Tell your supplier exactly where you'll use Stainless and how you'll fabricate it.

Minimize scrap losses at the mill by ordering the exact sizes that you will use.

Indicate, if possible, acceptable alternates in composition, gage and finish.

Holding your own scrap losses to a minimum to make the fullest use of the steel you receive is good shop practice anytime. It's especially important today.

Here are a few suggestions that may help you stretch your supplies. See that they are followed. Add other rules that your operations may dictate.

1. **Lay out your jobs to use steel as economically as possible. Then order to the closest possible size.**
2. **Keep your stock of Stainless Steel carefully separated by grades.**
3. **In your storage areas, make sure that surface finishes are protected properly.**
4. **Lay down strict rules for careful fabrication and handling. It will help you reduce rejections.**

No matter how carefully these rules are followed, there'll always be a certain amount of scrap. To keep new steel flowing to you, get your scrap back into circulation as quickly as possible by *promptly* turning in every pound to the mills.

AMERICAN STEEL & WIRE COMPANY, CLEVELAND · COLUMBIA STEEL COMPANY, SAN FRANCISCO
NATIONAL TUBE COMPANY, PITTSBURGH · TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM · UNITED STATES STEEL COMPANY, PITTSBURGH
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST · UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

U·S·S STAINLESS STEEL

SHEETS · STRIP · PLATES · BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

1-041

UNITED STATES STEEL

Patents

Material. R. T. Savage to Houdry Process Corporation.

In a process for the conversion of heavy, relatively non-volatile hydrocarbons with the use of fluent particle-form contact material, this material gravitates into a confined zone where it forms a wide compact bed. The gravitating material forms a freely falling curtain. The density and thickness of this curtain shall be sufficient at least to prevent passage therethrough of atomized liquid hydrocarbons, but freely permitting a desired penetration action to occur. An annular metering zone is located above the top surface of the bed of contact material for the control of this material gravitating to form said curtain.

U.S.P. 2,548,966. Catalytic Reactor. F. E. Gilmore to Phillips Petroleum Company.

The construction is claimed of an apparatus for contacting fluids with solids and of a cartridge containing a catalyst or the like and readily insertable into and removable from a contacting chamber.

U.S.P. 2,549,117. Fluidized Carbonization. K. J. Nelson to Standard Oil Development Company.

In a process for carbonizing fuels the plugging of gas-solid separators is prevented by special means.

U.S.P. 2,549,240. Acetylene Manufacture. S. P. Robinson to Phillips Petroleum Company.

A mixture of ethylene and hydrogen is contacted with a TiO_x catalyst at a temperature of 2000-2600° F. for 0.01-1.0 second. Acetylene is produced.

U.S.P. 2,549,961. Use of Blends of Tertiary Alkyl Mercaptans in Emulsion Polymerization. W. W. Crouch and E. G. Marhofer to Phillips Petroleum Company.

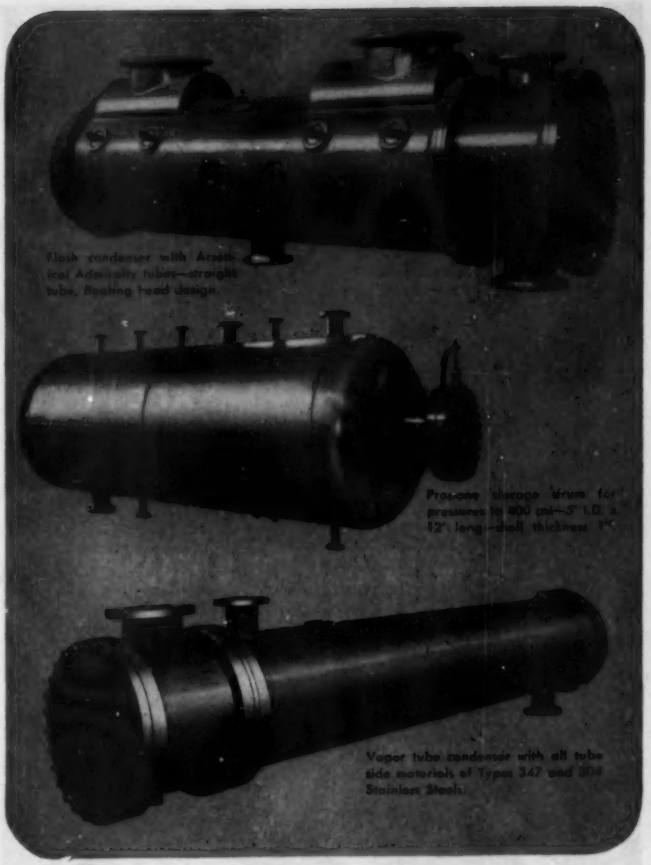
A major amount of butadiene and a minor amount of styrene are emulsion copolymerized in the presence of a modifying blend of tertiary alkyl mercaptans comprising 56 percent by weight of C_{12} mercaptans and 44 percent of tertiary C_{16} mercaptans in an amount such that the Mooney viscosity of the resulting polymer is 45-55. The polymerizing reaction is continued until 50-77 percent of the monomers are converted. A gel-free polymer is obtained.

U.S.P. 2,549,962. Use of a Blend of Tertiary Alkyl Mercaptans in Emulsion Polymerization. W. W. Crouch and E. G. Marhofer to Phillips Petroleum Company.

The process of this patent is very closely related to that of U.S.P. 2,549,-961. The modifying blend here comprises: one part of a mixture of tertiary octyl mercaptans, two parts of a mixture of tertiary C_{12} mercaptans, and two parts of a mixture of tertiary C_{16} mercaptans.

U.S.P. 2,550,089. Electrochemical Conversion of Hydrocarbons. C. H. Schlesman to Socony-Vacuum Oil Company, Inc.

Methane is subjected to a succession of pulses of ionizing electrical energy. Each of the pulses has a duration of 0.1-2500 microseconds followed by a rest period of substantially greater dura-

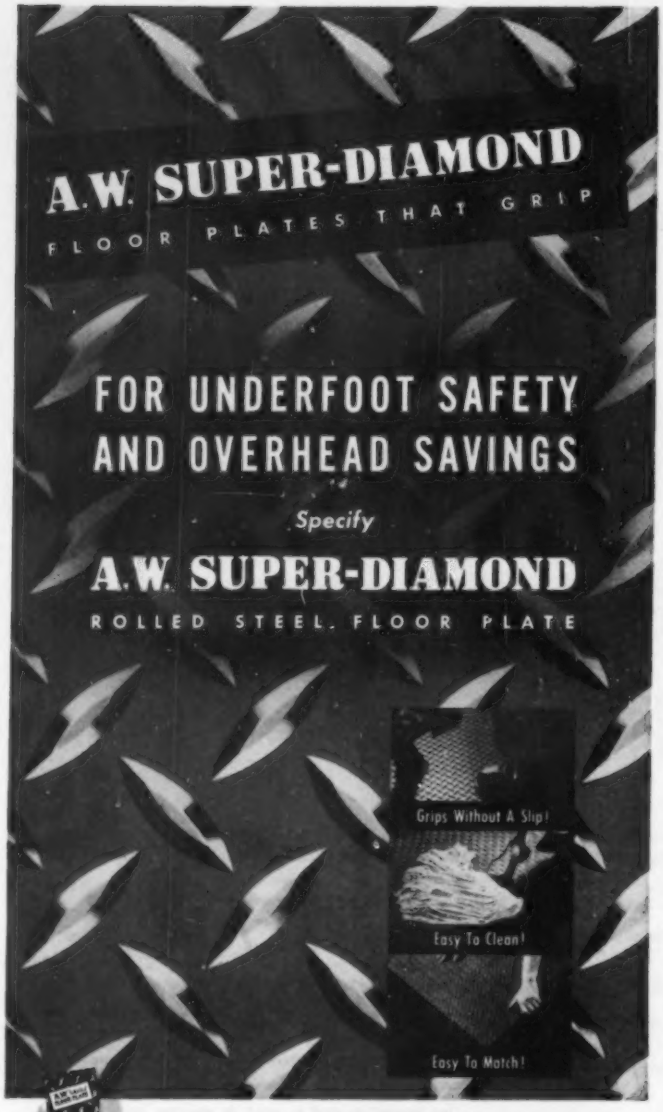

Flash condenser with Arsenical Admiralty tubes—straight tube, floating head design.
Vapor tube condenser with all tube side materials of Types 347 and 304 Stainless Steel.

MATERIALS are our "meat"

You can't stump Whitlock when it comes to materials. We're set up to handle complex fabricating and welding operations and to work to rigorous code or customer requirements. Whether the job involves welding aluminum, coiling nickel, rolling stainless steel, heat-treating Hastelloy, or practically any other operation on ferrous or non-ferrous metals, Whitlock facilities and techniques are equal to the task. Find out how Whitlock can serve you . . . write for Bulletin No. 945. The Whitlock Manufacturing Co., 75 South St., Hartford 10, Conn.

WHITLOCK

REPAIRS and BUILDS Bends • Coils • Condensers • Coolers • Heat Interchangers Heaters • Piping • Pressure Vessels • Reactors • Tubesheets


A.W. SUPER-DIAMOND
FLOOR PLATES THAT GRIP
FOR UNDERFOOT SAFETY
AND OVERHEAD SAVINGS
Specify
A.W. SUPER-DIAMOND
ROLLED STEEL FLOOR PLATE
Grips Without A Slip!
Easy To Clean!
Easy To Match!
Write for complete 16-page catalog C-52
ALAN WOOD STEEL COMPANY
CONSHOHOCKEN, PA.
125th A.W. YEAR
1826
125 Years of Iron and Steel Making Experience
Other Products: PERMACLAD Stainless Clad Steel • A. W. ALGRIP ABRASIVE
Floor Plate • Plates • Sheets • Strip • (Alloy and Special Grades)

Patents

tion. Hydrocarbons of lower mol. wt. are obtained.

U.S.P. 2,550,343. Removal of Silicon Tetrafluoride from Hydrocarbons. J. D. Gibson to Phillips Petroleum Company.

In the conversion of hydrocarbons in the presence of a fluorine-containing catalyst, the liquid conversion effluent is contacted with an organic fluorine-removing material containing a minor amount of silica. The effluent is thus contaminated with SiF_4 and water which are concentrated in the fractional distillation of the effluent. By treating a low-boiling fraction of the effluent with an iron oxide, the formation of siliceous deposits by hydrolyzation of SiF_4 is prevented and the latter is removed.

U.S.P. 2,550,695. Hydrogen Fluoride Catalyzed Polymerization of Diolefins. J. C. Hillyer and J. F. Wilson to Phillips Petroleum Company.

A mixture of butadiene and a paraffin with 4-7 C atoms as a solvent is contacted at a temperature of —110° to +20° F. with anhydrous HF. The mol ratio of solvent to butadiene shall be 1.5:1 to 5:1 and that of butadiene to HF shall be 1:1 to 25:1. Polybutadiene is recovered.

U.S.P. 2,550,741. Apparatus for Conversion of Hydrocarbons. A. B. Welty, Jr., to Standard Oil Development Company.

The construction is claimed of an apparatus for converting hydrocarbon gases in contact with finely divided fluidized solids of different density and reactivity. The apparatus is particularly suitable for the conversion of natural gas, methane, ethane, or the like into gas mixtures containing CO and H_2.

U.S.P. 2,550,742. Conversion of Hydrocarbon Gases to Hydrogen and Carbon Monoxide. A. B. Welty, Jr., to Standard Oil Development Company.

Details are claimed of a method of converting normally gaseous hydrocarbons by oxidation and reforming into gas mixtures containing CO and H_2 with the use of fluidized mixture of finely divided metal oxide and metallic nickel-containing reforming catalyst of a particle weight different from that of the metal oxide.

U.S.P. 2,550,922. Hydrocarbon Conversion Apparatus. W. S. Gullette to Sinclair Refining Company.

The construction is claimed of an apparatus for catalytically converting hydrocarbons and regenerating fouled catalyst. Novel means is provided for dissipating a portion of the heat of combustion of the carbonaceous material during this regeneration.

U.S.P. 2,550,948. Catalytic Contacting Apparatus. J. R. Tusson to Standard Oil Company (Indiana).

The construction is claimed of an apparatus for contacting fluids with solids at elevated temperatures and pressures in a continuous manner. The apparatus is of the rotating kiln type.

U.S.P. 2,551,145. Catalytic Cracking System. J. W. Loy to Phillips Petroleum

IS VACUUM THAT'S 99.99% PERFECT

good enough for your process?

THIS degree of vacuum is easily obtained with the Croll-Reynolds four or five-stage steam jet EVACTOR, with no moving parts. Each stage from a technical standpoint is as simple as the valve that turns it on. Numerous four-stage units are maintaining industrial vacuum down to 0.2 mm. and less, and many thousands of one, two and three-stage units are maintaining vacuum for intermediate industrial requirements on practically all types of processing equipment.

By permitting water, aqueous solutions or any volatile liquid to evaporate under high vacuum and without heat from an outside source, enough BTU's can be removed to chill the liquid down to 32° F., or even lower in the case of solutions. This is the principle of the Croll-Reynolds "Chill-Vactor." Hundreds of these have been installed throughout the United States and in several foreign countries.

An engineering staff of many years experience has specialized on this type of equipment and is at your service. Why not write today, outlining *your* vacuum problem?

CROLL-REYNOLDS

CROLL-REYNOLDS CO., INC.

17 JOHN STREET, NEW YORK 38, N. Y.

Chill-Vactors Steam Jet Evactors Condensing Equipment

PUMP ASPHALT!

The Kinney SD Rotating Plunger Pump is unequalled for handling asphalt and other heavy, viscous materials. Be sure you gain these extra pumping advantages by using the Kinney SD:

- ★ Rugged construction—heavy-duty shafts, bearings, plungers.
- ★ Simple design—no valves, blades, springs, gaskets . . . only one stuffing gland.
- ★ Large, unobstructed suction and discharge openings.
- ★ Meter-like volumetric accuracy—industries often use the Kinney Pump as a combined pump and meter.
- ★ Long-lasting efficiency—Kinney Pumps operate at full-rated capacity for years and years, and require a minimum of service expense.

There's a Kinney SD Rotating Plunger Pump for every asphalt handling job . . . in capacities from 2 GPM to 3000 GPM. Furnished plain or steam-jacketed to suit the job requirements. Send coupon for complete details. KINNEY MANUFACTURING CO., 3596 Washington St., Boston 30, Mass. Representatives in New York, Chicago, Cleveland, Houston, New Orleans, Philadelphia, Los Angeles, San Francisco, Seattle, and foreign countries.

Kinney LIQUID PUMPS

KINNEY MANUFACTURING CO.
3596 Washington Street
Boston 30, Mass.

Please send Kinney Liquid Pump Bulletin L48.

Name_____

Company_____

Address_____

Seven GOOD Reasons Why
You Get.....
• Smoother Performance,
• Longer Life,
• Better Service with
WECO Drop Side*
Snatch Blocks!
1
FORGED STEEL HOOK
Full swiveling . . . extra strength . . . blunt tip . . . straight-line pull.
2
DROP-SIDE*
Fast, easy stringing, without using end of line. Hinge plate secured with acme thread wing nut.
3
REGISTERED
Individual serial numbers assure registered quality.
4
SNARL-PROOF
Line can't bind between sheave and shell, or sheave and hook assembly.
5
CASE HARDENED SHEAVE PIN
Greater resistance to wear; accurately ground to size.
6
SUPER OILITE BEARING
Accurately "sized" for precision fit and even load distribution.
7
FORGED STEEL SHEAVE
Precision machined . . . gaged to new wire rope dimensions for longer rope life.
* Patented
WECO
WELL EQUIPMENT MFG. CORP.
Subsidiary of Chikan Company
HOUSTON 1, TEXAS
Exclusive Sales Representative Outside Mid-Continent Area
CHIKSAN COMPANY
Brea, Calif. Chicago 3, Ill. Newark 2, N. J.
Export Sales: CHIKSAN EXPORT COMPANY, Brea, Calif. Newark 2, N. J.
Manufacturers and Distributors of Oilfield, Refining, Marine and Industrial Equipment

Patents

Company.

The construction is claimed of a system for catalytic hydrocarbon conversion. Individual waste heat boilers are provided for each of a plurality of catalyst chambers to either quench the effluents of the on-stream chambers or cool the spent regenerative gases of the chambers on regeneration.

U.S.P. 2,551,336. Reduction Activated Peroxy Compound Catalyzed Synthetic Rubber Emulsion Polymerizations. R. L. Provost and F. J. Foster to U. S. Rubber Company.

A mixture of butadiene-1, 3 and styrene or another compound containing a single $CH_2{=}C\diagup\diagdown$ group is emulsion polymerized in the presence of a peroxy compound catalyst and certain amounts of ferrous sulfide activator prepared in situ and an alkali tartrate or citrate.

U.S.P. 2,551,641. Process of Reacting Alpha-Mono Olefins with Conjugated Hydrocarbons and Organic Peroxides and Products Produced Thereby. F. M. Seger, W. E. Garwood and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

A mixture of a normal alpha monoolefin having 5-18 C atoms, 0.01-1 molecule proportion of a conjugated hydrocarbon and 0.02-0.2 molecule proportion of an organic peroxide is heated at a temperature 120-400° F. The conjugated hydrocarbon can be substituted by a halogen or an alkoxy group.

U.S.P. 2,551,642. Synthetic Lubricants. W. E. Garwood, F. M. Seger, C. F. Feasley and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

The process according to this patent is related to that of U.S.P. 2,551,641. An aromatic hydrocarbon is here employed in an amount of 0.1-5 mol proportions instead of the conjugated hydrocarbon.

U.S.P. 2,551,760. High Styrene-Butadiene Copolymer and Process of Making Same. L. H. Perry to Union Bay State Chemical Company, Inc.

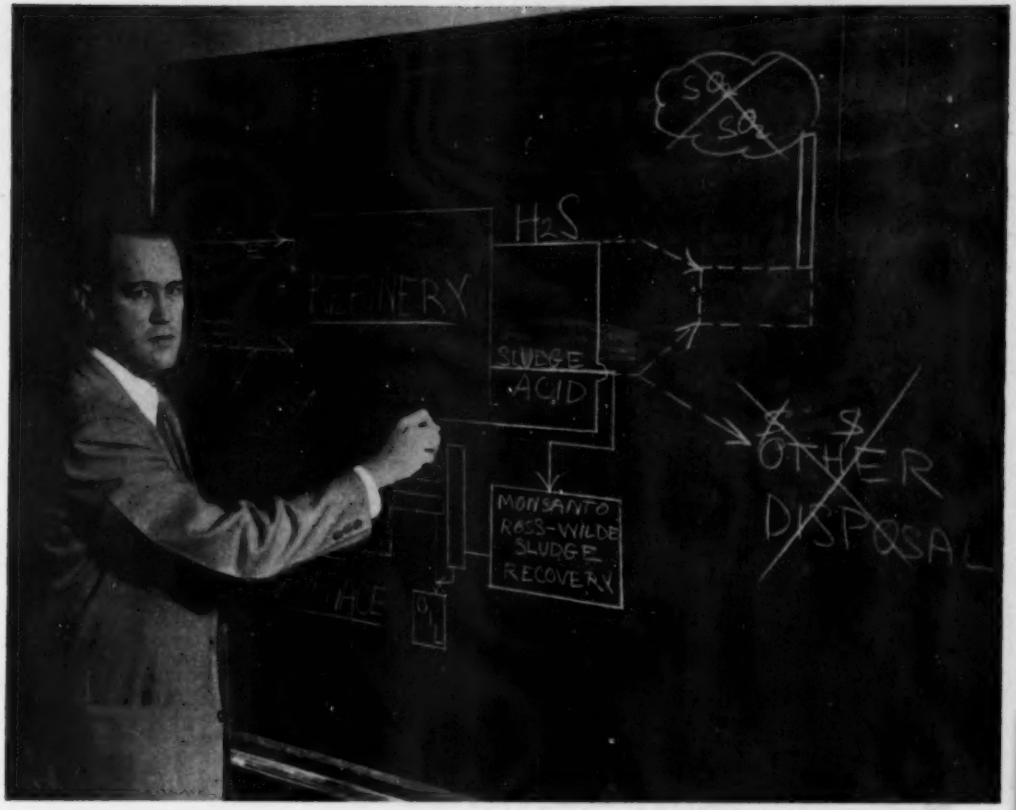
A mixture of a major portion of a vinyl benzene and a minor portion of a conjugated diene dissolved in a volatile solvent non-reactive with the monomers and non-polymerizing, is polymerized in the presence of 0.1-20 percent of a tertiary alkyl peroxide at a temperature of 70-150° C. for 5-100 hours. A colorless, clear, stable hydrocarbon resin is obtained which is soluble in straight-chain aliphatic naphthas.

CATALYST PREPARATION, ACTIVATION AND REGENERATION

U.S.P. 2,549,104. Method for Revivification of Desiccants. C. H. Lechthaler to Socony-Vacuum Oil Company, Inc.

A particle-form inorganic gel adsorbent spent as a desiccant by moisture adsorption is heated in several steps under specific conditions so that breaking-down of the gel is avoided and the desiccant is revivified for repeated use.

U.S.P. 2,549,844. Dehydrogenation Cata-



T. R. HARRIS, of Monsanto Engineering Sales, diagraming the Monsanto-Ross-Wilde process.

Sulfuric acid—problem today and tomorrow

Today's shortage of sulfuric acid is a problem that may well extend into the future. There are two factors indicating that it will remain long after the present emergency is over. First, sulfuric acid, most important of the heavy chemicals, is being used in more and more processes. Second, regardless of sulfur supplies, the increased use of sulfuric acid may make it difficult to obtain in desired quantities.

You can take a long stride toward solving *your* problem by recovering fresh, clean sulfuric acid from most types of refinery waste acids and from H_2S with a Monsanto-Ross-Wilde Sludge Recovery Unit. This unit can be linked with your present sulfuric acid plant, or can be built as a unit with a Monsanto-designed contact plant which produces new, white acids.

Monsanto-designed units will handle any type of fluid sludge without alteration, hence the plants will not become obsolete through changes in your processes which may result from reduced alkylation demand. Equipped with automatic controls, these easy-to-operate plants require a minimum of manpower.

Why not investigate this means of easing your sulfuric acid and waste disposal problems? At your request, a Monsanto representative will bring you complete information without cost or obligation. Write, wire or telephone MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 1776-E S. Second Street, St. Louis 4, Missouri.

Advantages of Monsanto-Designed Plants

AUTOMATIC CONTROLS, incorporated directly into the package unit, reduce manual attention to a minimum in the Monsanto-Ross-Wilde installation.

VARIOUS TYPES OF SLUDGE, containing low or high concentrations of acid, can be processed in Monsanto-designed plants.

EVEN HIGH-VISCOUS SLUDGE can be processed in the Monsanto-Ross-Wilde Unit by mixing it with more-fluid sludge.

☆ ☆ ☆ ☆

WRITE FOR BOOKLET *describing the Monsanto-Ross-Wilde process of sludge acid recovery.*

MONSANTO
CHEMICALS — PLASTICS

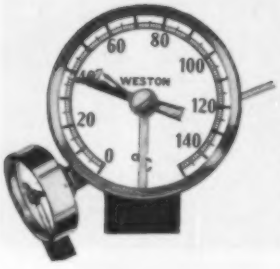
SERVING INDUSTRY...WHICH SERVES MANKIND

WESTON *Readable* ALL-METAL THERMOMETERS

—AVAILABLE IN THESE 3 TYPES

STANDARD INDUSTRIAL THERMOMETERS

All-metal dial types with stainless steel stems, in straight and angle forms. Scale lengths 3"—6" and 9", with stems from 2½" to 72". Available as testing thermometers, and for general purpose and heavy duty service. Ranges from −100 to +1000°F. All-metal construction prevents breakage, assures dependable accuracy for longer periods.



CONTACT MAKING THERMOMETERS

Combines the features of the all-metal indicating thermometer with an alarm or control device. Has adjustable contact arm mounted in the glass and bezel. Supplied to make contact on increasing or decreasing temperatures. Has positive magnetic type contacts. Contact rating . . . 100 ma at 110 volts a-c; 50 ma at 110 volts d-c. Stem lengths 2½" to 24".

MAX-MIN® THERMOMETERS

Equipped with a manually set red index which moves up or down scale with pointer, remaining at extreme temperature reached until reset. Thus one reading gives present temperature, and maximum or minimum reached since last reading. Available in scale lengths of 6" and 9"—stem lengths 2½" to 24".

Literature describing Weston all-metal, as well as electrical and glass thermometers, sent on request. WESTON Electrical Instrument Corporation, 638 Frelinghuysen Avenue, Newark 5, New Jersey . . . manufacturers of Weston and TAGliabue instruments.

WESTON *Instruments*

Patents

lyst. H. O. Mottern to Standard Oil Development Company.

A dehydrogenation catalyst consists of a mixture of ZnO, MgO, or BeO as a first component, 1-15 percent of ZrO_2, CeO_2 or ThO_2 as a second component, and 6-10 percent (based on the second component) of SiO_2, Fe_2O_3, or Al_2O_3, or a mixture thereof, as a third component.

U.S.P. 2,550,416. Hydrocarbon Synthesis Catalyst. C. N. Kimberlin, Jr., to Standard Oil Development Company.

A Fischer-Tropsch synthesis catalyst is derived from red iron oxide or magnetic iron oxide and is bonded together by means of an alkali metal silicate. It contains an alkali metal fluoride promoter, is treated in the oxide form at a temperature of 1100-1600° F., and is then reduced to the metallic iron state and suitably ground for allowing good fluidization.

U.S.P. 2,550,442. Preparation and Use of Synthesis Catalysts. R. A. Beck, E. E. Sensel, and A. J. Millendorf to The Texas Company.

A catalyst for Fischer-Tropsch synthesis is prepared from a solution of nitrate of Co or Ni containing supporting material and promoters. This solution is treated with an alkaline-ammonia compound. The resulting precipitate on the supporting material is freed from excess water, dried, and reduced by hydrogen at a temperature of 650-700° F. Finally CO and H_2 are passed into contact with the fresh catalyst at a temperature not above 300° F. prior to any use in the synthesis, whereupon the temperature of the CO/H_2 mixture is gradually increased to synthesis conditions.

U.S.P. 2,550,609. Addition of a Desiccant to a Fluidized Iron Reduction Process. W. L. Slater, Jr., to The Texas Company.

In the preparation of a Fischer-Tropsch synthesis catalyst, a stream of hydrogen is passed in contact with a powdered mass of an oxide of a metal of the iron group at reduction effecting temperature. The passage of hydrogen is continued until at least 80 percent of the powder is reduced to metal. A solid particle desiccant which combines with water vapor under the reaction conditions is then added. A dry solid product is formed which is ineffective to impair reduction of the metal and capable of being separated from the catalyst particles. Passage of hydrogen is continued under the reaction conditions until the reduction is completed, whereupon the desiccant is separated from the reduced catalyst.

U.S.P. 2,551,014. Preparation of Catalysts Containing Silica and Alumina or Magnesia or Both. C. N. Kimberlin, Jr., and J. P. Bilisoly to Standard Oil Development Company.

An aqueous slurry of magnesia is added to an acidic silica hydrosol which can be impregnated with an aluminum salt. The amount of the slurry shall be in excess over that required to neutralize the hydrosol, or sufficient to neutralize the free acid and to precipitate alumina. The resultant mixture is simultaneously converted to a silica-magnesia

THIS TIME IT'S

NACOGDOCHES, TEXAS

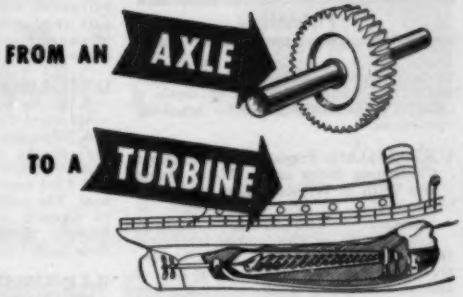
- Over in the prosperous timber and agricultural belt of east Texas, the city of Nacogdoches is looking and planning for further growth. Needing more water, municipal officials called in Layne and ordered the installation of another deep well and pump unit,—the third since 1925. With this new unit in operation, the city now has a greater supply of water than is presently needed.
- These three Layne installations extending back for more than a quarter century, have had every opportunity of failing,—or proving their value in high efficiency, long life and absolute dependability.
- Congratulations to Nacogdoches for the continued—and exclusive use of the world's finest wells and pumps.

LAYNE & BOWLER, INC.
General Offices, Memphis 8, Tenn.

ALL PURPOSE PUMPS

Layne's new catalog on Short Coupled Service Pumps will be sent on request. It fully illustrates the many practical applications of these wonderfully efficient all purpose pumps.

Layne
WATER SUPPLY
WELLS & PUMPS



WHEREVER PETROLEUM IS USED AS LUBRICANT OR FUEL

ADSORBENTS

have helped to prepare it!

From plain axle grease to the most highly refined and specialized motor oils—

From the most common commercial grade of fuel to aviation gasoline of the highest rating—

New sense is given to the old saying that "oil and water don't mix."

Wherever decolorization or dehydration enters into petroleum processing, Floridin products have been approved for forty years.

If you have use for natural adsorbents in any industrial process, these products should be of interest to you.

FLOREX FULLERS EARTH

High-pressure extrusion insures maximum effectiveness.

BAUXITE-BASED ADSORBENTS

Write for full data. The advice of a competent technical staff is offered. Your inquiry will get prompt attention.

FLORIDIN COMPANY
Adsorbents . . . Desiccants . . . Diluents

Dept. E, 220 Liberty St., Warren, Pa.

or a silica-alumina-magnesia hydrogel which is washed and dried to obtain a catalyst particularly useful for cracking operations.

U.S.P. 2,551,015. Preparation of Catalyst Containing Silica and a Metal Oxide and With or Without Magnesia. C. N. Kimberlin, Jr., and J. P. Bilisoly to Standard Oil Development Company.

The process of this patent is closely related to that of U.S.P. 2,551,014. Instead of the aluminum salt, a salt of any such metal is employed here which has the ability to form the hydrous oxide upon addition of magnesia to the silica hydrogel, such as maganese sulfate, zirconyl nitrate, beryllium nitrate.

U.S.P. 2,552,323. Process of Drying Hydrogel Microspheres. C. N. Kimberlin, Jr., to Standard Oil Development Company.

A gel catalyst consisting of spherically shaped particles below one mm. in diameter and useful in hydrocarbon conversions where powdered catalyst is suspended in the hydrocarbon vapors to be converted, is produced from an emulsion of a hydrosol of the catalytic components in a water immiscible liquid. Details are claimed.

HEAVY OILS AND WAXES

U.S.P. 2,549,525. Manufacture of Extreme Pressure Additives for Lubricating Oils. K. C. Roberts to The Anchor Chemicals Company, Ltd., Manchester, England.

A lubricating oil contains as an extensive pressure additive a compound obtained by heating sulfur with an unsaturated ester of an aliphatic alcohol having not more than two hydroxyl groups and with natural fatty acids having 16-24 C atoms in the presence of a small amount of a dicyclohexylamine.

U.S.P. 2,550,058. Production of Oil-free Wax and Dewaxed Oil from Wax-Bearing Lubricating Oil Stock With a Dewaxing Solvent Liquid. W. P. Gee to Texaco Development Company.

In the production of oil-free wax and dewaxed oil from wax-bearing lubricating oil stock with a dewaxing solvent, the solvent is modified by the incorporation of water prior to or during the recrystallization operation. Details are claimed.

U.S.P. 2,550,406. Extreme Pressure Lubricants. E. B. Cyphers to Standard Oil Development Company.

A mineral base lubricating oil contains 1-20 percent by weight of a sulfurized and phosphorized ester of an abietic compound esterified with an aliphatic compound of 12-22 C atoms. Further particulars of the additive and its production are given. The additive imparts extreme pressure properties to the lubricant.

U.S.P. 2,551,124. Lubricating Compositions and Additives Therefor. W. Helmore to C. C. Wakefield & Company, Ltd., London.

A mineral lubricating oil base contains 0.05-2 percent by weight, each, of tin petroleum sulfonate and chromium petroleum sulfonate. The additives impart good resistance to oxidation to the lubricant used in internal combustion engines.

U.S.P. 2,551,525. Stabilized Lubricants. R. E. Burk and E. C. Hughes to The Standard Oil Company of Ohio.

A lubricating oil contains 0.25-3 percent of the reaction product of phosphorus sulfide on cashew nut shell oil, and 0.5-3 percent of chromium naphthenate. The additives promote combustion of deposits in the combustion zone of internal combustion engines and produce high stability in the crank case.

U.S.P. 2,551,638. Production of Lubricating Oils by Condensation of Olefinic Hydrocarbons. F. M. Seger and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

Normal-alpha-monoolefinic hydrocarbons with 7-12 C atoms are contacted at a temperature of 50-300° C. with at least 0.02 mole of an organic peroxide per mole of the hydrocarbons. A lubricant with low pour point, high viscosity index and of high stability is obtained.

U.S.P. 2,551,640. Synthetic Lubricants. F. M. Seger, C. F. Feasley and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

A viscous oil is formed by reacting a mixture of one mol proportion of a halogenated olefin, 0.5-1.5 mol proportions of a normal alpha-monoolefin having 6-18 C atoms, and 0.01-0.3 mol proportion of an organic peroxide.

U.S.P. 2,551,644. Method of Preparing Synthetic Lubricants from Alpha Olefins. F. M. Seger, W. A. Garwood and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

A normal alpha monoolefin having 6-12 C atoms is non-catalytically heated in the presence of a thiol in a mol ratio of thiol to olefin of 0.001 to 0.1 at a temperature of 300-700° F. A viscous oil of low pour point, high viscosity index and high oxidation stability is produced.

U.S.P. 2,552,435. Lubricating Oil Treating Process. W. T. Knox, Jr., and R. L. Weeks to Standard Oil Development Company.

A continuous counterflow process is claimed in detail for contacting lubricating oils with silica gel as an adsorbent in order to improve the viscosity index of the oil.

U.S.P. 2,552,436. Process for Treating Lubricating Oil with Solid Adsorbents. G. A. Bennett and S. F. Perry to Standard Oil Development Company.

The process according to this patent is closely related to that of U.S.P. 2,552,435.

PETROCHEMICALS

U.S.P. 2,549,425. Condensation of Alkylated Naphthalene with a Sulfur Oxy-Halide in Presence of Friedel-Crafts Catalyst and Mineral Oil Compositions Containing Same. E. P. Cashman and E. Lieber to Standard Oil Development Company.

Equimolar proportions of an alkylated naphthalene containing more than 8 C atoms in the alkyl chain and an oxyhalide of sulfur, such as sulfuryl chloride, are reacted in the presence of a Friedel-Crafts catalyst at normal or elevated temperature. The wax modifying agent obtained can be incorporated as an additive in mineral lubricating oil to increase its pour stability.

U.S.P. 2,549,453. Anhydride Synthesis. W. F. Gresham and R. E. Brooks to E. I. du Pont de Nemours & Company.

CO, water, and an olefin of the formula $RR_1C=CR_2R_3$ wherein R-R_3, each, represent hydrogen or an alkyl radical, are heated at a temperature above 110° C. under a pressure of 25-2000 atmospheres in the presence of a nickel carbonyl or substances which form a nickel corbonyl under the reaction conditions. The amount of water in the treated mixture shall be less than that stoichiometrically required for the formation of carboxylic acid from the mixture of components. A carboxylic acid anhydride of the formula $(CHRR_1CR_2R_3O)_2O$ is formed.

U.S.P. 2,549,455. Production of Esters from Olefinic Compounds, Carbon Monoxide, Hydrogen and Organic Carboxylic Acids. W. F. Gresham and R. E. Brooks to E. I. du Pont de Nemours & Company.

An olefin, CO and H_2 are interacted with an organic carboxylic acid in the presence of a catalytic amount of an organic carboxylic acid salt of Co or Ru at a temperature of 140-375° C. and a pressure in excess of 300 atmospheres. Esters are thus produced.

U.S.P. 2,549,565. Method of Fluorinating Organic Compounds with Molten Silver Fluorides. R. G. Benner to the U. S. Atomic Energy Commission.

Hydrocarbon and elemental fluorine are introduced at different separate positions into a molten mass of 20-70 percent of AgF and 80-30 percent of AgF_2 agitated at a temperature of 200-500° C. The amount of fluorine introduced shall be such as to maintain the fluorine content of the molten mass substantially constant. Fluorinated hydrocarbons are obtained.

U.S.P. 2,549,600. Synthesis of 5-(2-Thenoyl) Pentanoic Acid from Thiophene, Adipyl Chloride and Silica-Alumina Catalyst. H. D. Hartough and A. I. Kosak to Socony-Vacuum Oil Company, Inc.

Thiophene and adipyl chloride are reacted in the presence of a silica-alumina catalyst to produce 5-(2-thenoyl) pentanoic acid.

U.S.P. 2,549,651. Pyridine Preparation. C. A. Weisgerber to Hercules Powder Company.

A conjugated diolefin, such as butadiene, is reacted in the vapor phase and in the presence of an aluminum oxide catalyst with an alkyl nitrile, such as acetonitrile. A pyridine, such as 2-picoline or 2,4,5-trimethyl pyridine, is produced.

U.S.P. 2,549,913. Copolymer of Acrylonitrile and Isobutene and Method for Its Production. M. R. Lytton to American Viscose Corporation.

Thirty-seven parts by weight of isobutene are copolymerized with twelve parts of acrylonitrile at 50° C. under pressure while stirring for 60 hours in an aqueous medium containing sodium

PETROLEUM CHEMICALS DIVISION
NEWS

July ★ One of a Series of Interest to the Petroleum Industry ★ 1951

Next Du Pont Gasoline Survey Due Week of July 23

Refiners will start getting results of the latest Du Pont Quarterly Nation-wide Gasoline Survey on July 23.

Because interest in octane numbers is running high, this issue of the survey has been eagerly awaited.

As an indicator of trends, many refiners will find it of particular value.

AFTON D. PUCKETT
Translates Lab Work Into Technical Service

Afton D. Puckett coordinates the operations of the five district laboratories of the Du Pont Petroleum Chemicals Division in their performance of technical services. He also supervises technical work connected with the quarterly Motor Gasoline Survey.

After receiving a chemical engineering degree from Oklahoma A & M College in 1936, Mr. Puckett became an engineer for the Tide Water Associated Oil Co. From 1941 to 1946 he served as fuels chemist and petroleum engineer with the National Bureau of Standards. He then worked on diesel fuel problems at the U. S. Bureau of Mines Petroleum Experiment Station at Bartlesville, Okla.

In 1947 Mr. Puckett came to Du Pont to take charge of the studies of antiknock properties of motor fuels in the Du Pont Combustion Engineering Laboratory at Deepwater Point, New Jersey. He is the author of several technical papers on combustion characteristics of motor and diesel fuels.

Fast Legwork, Synchronized Teamwork Make Du Pont Gasoline Survey Accurate and Up-To-Date

To be of interest and value to you, the news in your daily newspaper must be always fresh. The same is true with the Du Pont Quarterly Nation-wide Gasoline Survey which shows, by areas, the national trend in gasoline octane ratings and tetraethyl lead content.

Survey samples are purchased by Du Pont representatives at the islands of service stations with active turnover.

The whole survey operation – from sample collection to delivery of published results – is completed in 3 weeks or less. Working on such a tight schedule takes highly synchronized teamwork. And fast legwork, too.

For efficiency, one man is generally responsible for the whole sample collection in an area. But it's a big job—and speed is imperative. In each of the five districts, from 100 to 175 individual samples are collected . . . all within 48 hours.

Dave Rickard, for example, flies many air miles every 3 months to pick up gasoline at 24 service stations in Denver, Colo.; Casper, Wyo.; Great Falls, Mont. and Aberdeen, S. D.

To enable the Du Pont representative to make his rounds at top speed and efficiency, the sample cans are tagged ahead of time. And they are already waiting for him at the express office when he arrives in the cities on his route.

Extreme difficulties often have to be overcome to meet the schedule. An unusually heavy snowstorm dealt a tough problem to Herb Cissley. He had to get his car, which was securely snowed-in, out of his garage in a hurry. He finally had to hire a bulldozer to plow out the driveway. Some of the driveway surface got misplaced – but he made his collection on time.

Both the sample towns and the gasoline brands are carefully selected. Source of supply and position in marketing area dictate the choice of cities. The brands picked are believed representative of the range of quality in the area. All samples are obtained from service stations appearing to have a reasonable turnover. And to assure a uniformly accurate trend, the same sta-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

PETROLEUM CHEMICALS DIVISION
NEWS

CONTINUED *Gasoline Survey*

tions are generally sampled for each survey.

Only a few hours after samples leave the marketers' islands, they are being evaluated. Each of the five Du Pont District Laboratories shares in this work. Here they are tested for both motor and research octane ratings, as well as lead content.

Working at top speed—checking and rechecking for accuracy – the laboratory staffs take only about a week to test nearly 700 individual samples, both regular and premium.

As soon as possible after collection, samples are rushed to the nearest district laboratory.

While the testing is being done at the district laboratories, the Wilmington staff is getting in gear for the big push of compiling, printing and mailing the results. To save printing time, as many of the forms as possible are set up before printing deadline. Only the final results have to be added at the last minute.

In addition to the regular survey report, a running account of current trends in eight strategically located cities is published in graph form. These bar graphs show the average results of all Du Pont quarterly surveys since 1948 in Philadelphia, Detroit, Chicago, Tulsa, Houston, Denver, Los Angeles and San Francisco. The graphs are brought up to date with last-minute information for each publication of the survey.

The survey is one of the Du Pont services available to refiners and marketers. When the next issue reaches your desk, it can be extremely valuable to you in planning your marketing activities . . . with its *timely, accurate* picture of nation-wide conditions.

"DULUX" TANK WHITE SPECIALLY FORMULATED FOR GASOLINE STORAGE TANKS

Like many other Du Pont products, "Dulux" Tank White was formulated by Du Pont paint chemists especially with the petroleum industry in mind. In developing a finish that would be suitable for gasoline storage tanks many factors had to be taken into consideration.

Perhaps the greatest single contribution of "Dulux" Tank White is the savings it effects through cutting down gasoline evaporation losses from the tanks. This is made possible by the special combination of pigments used in its formulation, which assures the whitest possible white, and the maximum of light and heat reflection.

In "Dulux" Tank White, excellent surface protection is imparted by the famous "Dulux" resin which resists cracking, checking and loss of adhesion.

"Dulux" resin, too, slows down the wearing process of the paint . . . gives it a high degree of durability over long periods of time.

Another important quality of "Dulux" Tank White is its unusual resistance to the fumes generally found in refinery locations.

A self-cleaning characteristic of this paint tends to keep a tank farm looking its bright and shining best for long periods of time. It also preserves the light and heat reflective qualities of the finish at a high level.

Du Pont Movie Library Available to Oil Co's

Movies are playing an increasingly important role in industry . . . as selling tools, as personnel relations aids, and for explaining highly technical subjects simply and dramatically.

The Du Pont Petroleum Chemicals Division has now set up an extensive library of movies that have particular interest to the Petroleum Industry.

A scene from "The Du Pont Story." This dramatic, technicolor movie emphasizes progress through research—traces the history of the Company from its beginnings.

From automotive maintenance to safety . . . from farming to factory "color conditioning" . . . from the prehistoric formation of oil to the properties that make a modern gasoline . . . these movies cover a broad variety of subjects related to petroleum and its uses. Films made for the U. S. Bureau of Mines and various petroleum companies, as well as Du Pont films, are included.

These films are available to you for your own use. And you can obtain a complete listing of the library from the nearest Du Pont Petroleum Chemicals Division District Office.

LITERATURE AVAILABLE

The following is a partial listing of free Du Pont bulletins, reports, booklets and aids available to you. Address request to your nearest Du Pont Petroleum Chemicals Division District Office.

Du Pont Gasoline Antioxidants Nos. 5, 6 and 22—describing their use and application for improving gasoline storage stability . . . . . Serial A-513

Blending calculator for Du Pont TEL Compound (Aviation Mix) . . . . . Serial A-1210

DU PONT
REG. U.S. PAT. OFF.
Better Things for Better Living . . . through Chemistry

Petroleum Chemicals

E. I. DU PONT DE NEMOURS & COMPANY (INC.)
Petroleum Chemicals Division • *Wilmington 98, Delaware*

District Offices: New York, N. Y. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · Los Angeles, Calif.

District Laboratories: Wilmington, Del. · Chicago, Ill. · Tulsa, Okla. · Houston, Texas · El Monte, Calif.

IN CANADA: Canadian Industries Limited — Toronto, Ontario — Montreal, Quebec

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

A-2170

Printed in U. S. A.

oleate as an emulsifier and potassium persulfate as a catalyst.

U.S.P. 2,551,572. Production of Thiophene Carbonitriles. W. I. Denton and R. B. Bishop to Socony-Vacuum Oil Company, Inc.

An Alkyl thiophene is contacted with ammonia at a temperature between 850° F. and the ammonia decomposition temperature in the presence of a Mo or V oxide catalyst.

U.S.P. 2,551,639. Reaction of Olefins and Halogenated Alkanes. C. F. Feasley and W. A. Stover to Socony-Vacuum Oil Company, Inc.

A mono-olefin, such as octene-2, is contacted with a Cl- or F- alkane, e.g. C Cl_4, at a temperature of 150-350° C. and a pressure sufficient to maintain the reactants in liquid state. An unsaturated monomer, e.g. $C_8H_{15}Cl_3$ is formed.

U.S.P. 2,551,643. Synthetic Lubricants from Alpha-Monoolefins and Unsaturated Esters and Method for Producing the Same. F. M. Seger, W. E. Garwood, and A. N. Sachanen to Socony-Vacuum Oil Company, Inc.

One mol proportion of a normal alpha monoolefin having 8-12 C atoms, 0.01-1 mol proportion of an unsaturated organic ester of special constitution, and 0.02-0.2 mol proportion of an organic peroxide are condensed at a temperature of 50-200° C. Synthetic lubricating oil is produced.

U.S.P. 2,551,675. Production of Adipic Acid. J. C. Hillyer and J. T. Edmonds to Phillips Petroleum Company.

Details are claimed of a process for producing adipic acid from butadiene, water, and furfural.

U.S.P. 2,551,813. Free Radical Addition of H_2S to Olefins. P. S. Pinkney to E. I. duPont de Nemours & Company.

Hydrogen sulfide is added to a terminally ethylenically unsaturated hydrocarbon in the presence of an azo compound of special constitution, such as 1,1'-azobis (1-cyanalkane) wherein the two C atoms are each attached to azo nitrogen and a cyano group and are tertiary. Mercaptans and/or sulfides are produced.

U.S.P. 2,552,267-8. Liquid Phase Oxidation. W. S. Emerson and R. A. Heimsch to Monsanto Chemical Company.

Dialkylbenzenes having 1-4 C atoms in the alkyl groups are contacted preferably at a temperature of 140-200° C. with an oxygen containing gas in the presence of a metal oxide or metal salt catalyst and a metal salt of acetylacetone or the like as promoter. Instead of the latter hexachlorethane can be employed. Dicarboxylic acids are produced.

U.S.P. 2,552,278. Liquid Phase Oxidation. C. A. Hochwalt to Monsanto Chemical Company.

The process according to this patent differs from those of U.S.P. 2,552,267-8 only in that a tetraalkyl lead is employed as the catalyst promoter.

U.S.P. 2,552,425. Method of Producing Vinyl Chloride. P. Halbig, Fribourg.

Acetylene and HCl vapor are conducted over a heated catalyst containing $HgCl_2$. Details of the process are claimed for producing vinyl chloride in high concentration.

U.S.P. 2,552,466. Stabilized Aromatic Amine-Gasoline Mixtures. W. J. Sweeney to Standard Oil Development Company.

A composition comprising gasoline and a mononuclear aromatic amine with 1-3 alkyl C atoms such as at least 1 percent xylidene, is stabilized by a small amount (e.g. 0.0001-0.01 percent by volume) of a 2,4-dialkyl phenol in which at least one alkyl substituent is a primary or secondary alkyl radical, e.g. 2-tert. butyl p-cresol.

DESULFURIZATION

U.S.P. 2,549,052. Desulfurization of Hydrocarbon Oils. K. M. Brown and W. W. Johnstone to Universal Oil Products Company.

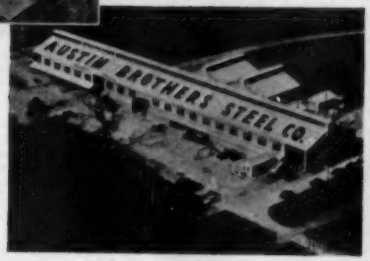
Acidic organic compounds, such as mercaptans, are removed from hydrocarbon oil heavier than gasoline by contacting the oil with a caustic-solvent solution (e.g. an alkali-methanol solution) containing 2-20 volumes of heavy xylenols per 100 volumes of this solution.

U.S.P. 2,549,053. Treatment of Hydrocarbons. K. M. Brown to Universal Oil Products Company.

Sour hydrocarbon oil is treated with a caustic-solvent solution. A mercaptan fraction separated from this treating step is supplied to a second hydrocarbon oil subjected to a high temperature conversion treatment. H_2S and hydrocarbon are formed. Mercaptan-containing hy-

SERVING THE INDUSTRY

FROM 2 GREAT PLANTS



- Structural Steel
- Reinforcing Steel
- Steel Warehouse Products

AUSTIN BROTHERS STEEL CO.

GENERAL OFFICES:
1815 COOMBS STREET
DALLAS 1, TEXAS

PLANTS:
DALLAS, TEXAS
HOUSTON, TEXAS

Member of a Great Pump Family

There is a PUMP by Aurora for every pump job.
TYPE-OD
Aurora Horizontally Split-Case, Double Suction, Single Stage Centrifugal Pump.
For general water supply for municipalities, industries, office buildings, institutions—also—for handling liquids, chemical solutions, oils etc., in a wide variety of industries. Write for Bulletin 105-M for further details.

DISTRIBUTORS IN PRINCIPAL CITIES

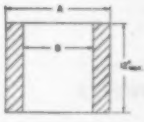
AURORA Always PUMPS — AURORA PUMP COMPANY

LENAPE
FORGED AND PIERCED RINGS
Save Hours of Machining Time

Designers and fabricators are taking advantage of the inherent economy of Lenape pierced rings of the type illustrated —the OD and ID are press formed to rough dimensions in one operation, thus saving metal and hours of machine time compared to producing from bar stock.

Use Lenape heavy rings at less overall cost!

Lenape forged and pierced rings in carbon, alloy and stainless steels are produced in a wide range of sizes from 6" OD x 3½" ID to 17" OD x 14" ID rough machined or finished to specification.



Rings of this type are frequently used as auxiliary tank fittings, heavy machinery parts, as rollers, bearing sleeves, and stuffing boxes.

Lenape forged and pierced rings are covered in detail on page 46 of Lenape Catalog 9-49. A copy will be sent upon request. Your specific inquiry will be given our immediate attention.

LENAPE HYDRAULIC PRESSING AND FORGING CO.

LENAPE HYDRAULIC PRESSING & FORGING CO
DEPT. 106 WEST CHESTER, PA.

RED MAN PRODUCTS

Patents

drocarbons from this second treating step are supplied to the first step.

U.S.P. 2,550,091. Mercaptan Removal from Hydrocarbons. J. E. Seebold to Standard Oil Company (Indiana).

A mercaptan-containing lower aliphatic alcohol obtained by distillation from a caustic-alkali solution spend in desulfurizing sour petroleum hydrocarbons is fractionally distilled in contact with an oxidizing gas stream.

U.S.P. 2,550,668. Hypochlorite Sweetening Process. R. C. Brandon and M. C. K. Jones to Standard Oil Development Company.

Petroleum oil containing mercaptan compounds is contacted with an alkali hypochlorite solution. This solution contains 2-10 grams per liter of the alkali hypochlorite, 50-250 grams per liter of alkali hydroxide, and 50-200 grams per liter of an alkali metal chloride salt. The mercaptan compounds are removed by the treatment.

U.S.P. 2,550,905. Mercaptan Removal. J. A. Bolt and T. B. Tom to Standard Oil Company (Indiana).

Details are claimed of a process for removing mercaptans from petroleum distillates by extraction with an aqueous alkali metal hydroxide solution of certain concentration in the presence of cresols, and subsequent reactivation of said solution.

U.S.P. 2,551,905. Desulfurization of Gases. S. P. Robinson to Phillips Petroleum Company.

Hydrocarbon gases containing H_2S and organic sulfur compounds are continuously desulfurized by means of hot spherical pebbles comprising a catalyst for promoting decomposition of the sulfur compounds and an acceptor for sulfur. Details of the process are claimed.

U.S.P. 2,552,399. Treating Petroleum Distillates. J. G. Browder to Standard Oil Development Company.

Sour petroleum distillate containing mercaptans and having a final b.p. of not more than 750° F. is sweetened by adding a small catalytic amount of a benzenoid compound selected from the amines and phenols, such as hydroquinone, pyrogallol, p-aminophenol, or p-phenylene diamine, not more than 5 percent by volume of a solution of an alkali metal hydroxide, and a mild oxidizing agent to convert the mercaptans to disulfides.

Two Operational Records Claimed by Cities Service

Petroleum processing history is claimed by Cities Service Oil Company for its East Chicago fluid catalytic cracking unit which recently completed a record initial run of 785 days before being shut down for the first turnaround. During this test run 11,914,000 barrels of virgin gasoil was processed into high test gasoline.

Cities Service also claimed an all-time record for continuous operation on other than an initial run for its Lake Charles, La., cat cracker which has been operating more than 900 days since its last turn-around and "is still going strong."

SAFE
STRONG
SECURE

Before specifying or purchasing open steel flooring check these exclusive features of Blaw-Knox Grating . . .

1. SAFETY underfoot at all times assured by twisted steel cross bars.
2. STRENGTH that only rigid "one-piece" Electroforged construction can provide.
3. SECURITY—no wobble, tilt or rattle caused by loose or lost screws, nuts, bolts.
4. EASY to maintain and paint . . . no sharp corners to clog with dirt.
5. MAXIMUM open area for light and air.

For complete data on Blaw-Knox Electroforged Steel Grating and Stair Treads write for Bulletin 2365.

BLAW-KNOX DIVISION
OF BLAW-KNOX COMPANY
2005 Farmers Bank Bldg., Pittsburgh 22, Pa.

BLAW-KNOX
Electroforged®
STEEL GRATING
AND STAIR TREADS

BOOKS

Standardized Control Valves

Uniform Face to Face Dimensions for Flanged Control Valve Bodies, ISA RP4.1, Instrument Society of America, 921 Ridge Avenue, Pittsburgh 12. Twenty-five cents.

Practices recommended by the ISA are published in an attempt to achieve uniformity in the field of instrumentation. Dimensions under consideration are the face-to-face body dimensions for flanged end valves of both cast iron and steel through 600-pound flange ratings. Sizes included are ½ through 8 inches. Only flanged valves which are in the category of diaphragm actuated control valves of the plug type are included. The dimensions were developed by the majority of control valve manufacturers with the assistance of the National Steam Specialty Club, when it became known that the user industry was 100 percent in agreement that uniform face-to-face dimensions for control valves were desirable.

This ISA publication urges adoption of the dimensions treated by all control valve manufacturers to allow piping design, where control valves are involved, without special consideration to the make of equipment to be used.

Research Projects Enumerated

Review of Current Research and Directory of Member Institutions, 1951, edited by John I. Mattill, for the Engineering College Research Council, Massachusetts Institute of Technology, Cambridge 39, Mass. $2.25.

More than 5200 engineering research projects are currently active in the engineering schools of American colleges and universities according to the Council and this publication is a complete enumeration of the contributions made through March 1 by the 91 schools holding membership in ECRC.

The volume contains research project titles, names of research administrative officers responsible for each project, a brief digest of policies which govern research projects and contracts at each institution, the number of personnel engaged in research activities, the annual expenditures, and special conferences and short courses of interest to research workers.

ECRC publishes this information to serve as a guide to the effective research activities and capacity in American engineering colleges and universities.

Uniformity to Include Flowmeter

Flowmeter Installations, Seal and Condensate Chambers, ISA RP 3.1, Instrument Society of America, 921 Ridge Avenue, Pittsburgh 12. Fifty cents.

This is another of the publications issued by ISA to induce interest and activity in the move to effect uniformity of instrument dimensions. This booklet deals with tentative recommended practices, and explains that head-type fluid meter installations will be simplified by the adoption of uniform practices in the fabrication of their seal and condensate chambers. This uniformity pertains to the overall dimensions, general arrangement and location of connections, and

Whiton SOLID STEEL ROTOR STEAM TURBINES

WHITON LABYRINTH SHAFT SEAL . . . SINCE 1911

Whiton Turbines in service 25 years without seal replacement

Because:

- **Factory run-in assures perfect seal and minimum wear.**
- **Labyrinth seals do not contact shaft, eliminating wear and seizing.**
- **Steam ejector feature positively prevents steam leakage at outer end of shaft seal.**

Write for complete details.

Mr. Whiton since 1856
WHITON MACHINE COMPANY
New London 14, Conn., U.S.A.

GERONIMO
FOR THE SAFETY OF YOUR MEN IN REFINERIES AND NATURAL GASOLINE PLANTS
ESCAPE DEVICE
NET WEIGHT 15 LBS.
GLIDE TO SAFETY ON GERONIMO
(Patent Applied For)

GERONIMO will stand hardest wear and give unfailing protection to refinery and derrick men whose lives are endangered by fire, escaping gases or other hazards.

EASILY ATTACHED OR REMOVED
EXTRA STURDY CONSTRUCTION
QUICKLY STRADDLED
POSITIVE, INSTANT BRAKE
BRONZE "No-Spark" SURFACES
RECOMMENDED FOR ½" WIRE LINE

• Write for Illustrated Folder •

— MANUFACTURED BY —
CHARLIE'S MACHINE WORKS
PERRY, OKLAHOMA

Books

the minimum sealing volume required by conventional meters.

Pursuant to the adoption of the recommendations, all similar types of seal and condensate chambers would be interchangeable with respect to installation dimensions, regardless of their source of supply.

New Adsorption Data

Adsorption, Dr. C. L. Mantell, McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18. $9.

Particular change in treatment in this revision of an earlier edition includes material on fuller's earth, clays, and aluminum oxide base materials; ion exchangers; solvency recovery; gas hydrates; dehydration of air and gases (including a section on controlled humidity for preservation of materials).

New sections to be found only in the revised edition include fractionation of hydrocarbons by adsorptive processes; dehydration of liquids and the refining of waxes; the fractionation of ions with particular reference to the rare earths, fission products, and other work of the Plutonium Project; adsorbents in the refining of sugar and related substances; water treatment involving deodorization, removal of tastes, etc.; adsorbents in medicine and pharmacy.

All material dealing with detailed testing procedures, specifications, etc., has been revised and rewritten in cooperation with the standardizing agencies and the producers and users of adsorbent materials.

Reprint Policy

For small, individual orders of reprints of its articles PETROLEUM REFINER makes a charge of 50 cents per copy WHEN REPRINTS ARE AVAILABLE.

The charge for tear sheets of a particular article when available is 25 cents.

Cash or company requisitions should accompany all such "individual" orders.

This change does not affect the price for quantity orders of reprints (starting at 100 orders) which will be quoted upon request. Address Editor, PETROLEUM REFINER, Box 2608, Houston 1, Texas.

"INFERNO" STEAM HOSE...

SIZES ¾" TO 2" I.D.
PRESSURES TO 200 LBS.
TEMPERATURES TO 400°F.

The Hose With a Reputation for Safety and Long Service

Goodall has built into "INFERNO" the high factor of safety and the qualities insuring extra long service life that make this hose so desirable and economical for every refinery steam service.

The tube offers remarkable resistance to hardening and cracking under high temperatures. Tightly braided galvanized steel wires reinforce the rugged, heat-resistant carcass. The tough red cover withstands severest abrasive wear and all conditions of weather. Available in maximum lengths of 50 feet.

STYLE D-162 has patented Static Wire and Neoprene Cover.

PARTICIPATING IN THE MANAGEMENT AND FINANCING OF KENTUCKY SYNTHETIC RUBBER CORPORATION

Contact Our Nearest Branch for Complete Information

GOODALL RUBBER COMPANY

GENERAL OFFICES, MILLS and EXPORT DIVISION, TRENTON, N. J.

Branches: Philadelphia · New York · Boston · Pittsburgh · Chicago · Detroit · St. Paul · Los Angeles
San Francisco · Seattle · Portland · Salt Lake City · Denver · Houston · Distributors in Other Principal Cities

Est. 1870

History of Helium Research

Bureau of Mines Bulletin 486, *Helium-Bearing Natural Gases of the United States, Analyses and Analytical Methods*, C. C. Anderson and H. H. Hinson. Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. $0.75 per copy.

Analyses of more than 2,100 samples of natural gases from 30 states, representing Bureau of Mines surveys for helium-bearing gases made over the past 33 years, is presented in tabular form and contains detailed information about the Bureau's methods of collecting and analyzing the samples. The bulletin sketches briefly the historical background of the survey from the beginning of the government's helium program in 1917 to the close of 1948.

Such developments as the experimental helium-production under the Bureau of Mines, the beginning of commercial-scale helium production at Fort Worth, Texas, by the Navy, and subsequent erection of the first Bureau of Mines helium plant at Amarillo in 1928 are included in the sketch as well as early discovery and problems.

The bulletin is authored by Anderson, assistant chief of the Bureau's Petroleum and Natural Gas Branch, and Hinson, former assistant supervising engineer of the Bureau's helium plants at Amarillo, Texas. Obtainable only from Superintendent of Documents, address as listed above.

Recent API Publications

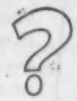
Part IV—Low-Pressure Storage Tanks, from the Manual of Recommended Practices for Refinery Inspections, and *API Standard on Flanged and Welding-End Steel Wedge-Gate and Plug Valves for Refinery Use* from API Standard 600; Division of Refining, American Petroleum Institute, 50 West 50th Street, New York 20. First priced at $1; second at $1.50.

Parts I, II and III of the refinery inspections manual are still available through the API at the following prices: Part I, "Process Equipment," $3; Part II, "Pressure-Relieving Devices," $75; and Part III, "Fire-Protection Equipment," $1.

Standard 600 was published as a tentative bulletin in 1949 but the current edition has been revised slightly and elevated to the status of a full standard.

Carbon, Alloy and Stainless steel tubes are defined under CMP regulations as "controlled materials". As such, they are critical materials. Not being a mind reader, "Mr. Tubes"—your B&W Tube Company representative—needs a *close* look at the following facts in order to supply the available tubing most economically suited to your requirements.

1 All related CMP authorizations and government contract numbers.



2 Any acceptable alternates in type, finish, composition, and size.

3 A brief, informative description of your intended fabricating methods.

4 A description of the end-use, exact as to product and its service.

THE BABCOCK & WILCOX TUBE COMPANY

Executive Offices: Beaver Falls, Pa.

General Offices and Plants

Beaver Falls, Pa.—Seamless Tubing; Welded Stainless Steel Tubing
Alliance, Ohio—Welded Carbon Steel Tubing

Sales Offices: Beaver Falls, Pa. • Boston 16, Mass. • Chicago 3, Ill.
Cleveland 14, Ohio • Denver 1, Colo. • Detroit 26, Mich.
Houston 2, Texas • Los Angeles 15, Calif. • New York 16, N. Y.
Philadelphia 2, Pa. • St. Louis 1, Mo. • San Francisco 3, Calif.
Syracuse 2, N. Y. • Toronto, Ontario • Tulsa 3, Okla.

B&W SEAMLESS and WELDED TUBES

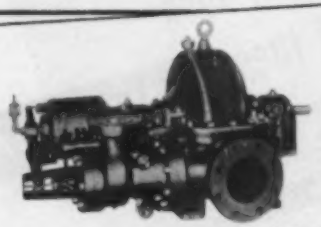
TA-1640-O

5 Ways

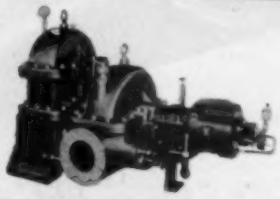
TO MAKE YOUR STEAM DO MORE WORK...

Power-Saving Worthington Turbines Cut The Operating Costs Of Mechanical Drives

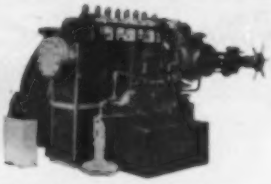
Worthington Turbines are built in all sizes and types — including straight condensing, straight non-condensing, extraction, mixed pressure extraction, low pressure and high back pressure — to meet the widest range of requirements. Steam or gas driven, for mechanical or generator drive, all are available with governors for constant or variable speeds. If desired, control devices can be incorporated in the governor.



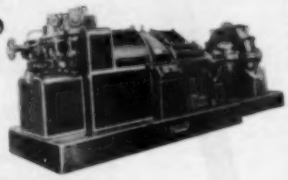
Single Stage. Sizes up to 1500 hp. Particularly adapted for driving all types of pumps, fans, small blowers and other auxiliaries where simplicity of construction and reliability are of prime importance.



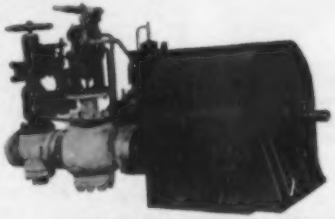
Single Stage With Integral Reduction Gear. Sizes up to 200 hp. A compact, sturdy, dependable unit with economical turbine operation. Especially suited for driving slow or moderate speed auxiliaries at low steam consumption.



Multi-Stage. Sizes up to 20,000 hp, and all types. Longer blade-life and more economical than single stage turbines especially on larger horsepowers and at slow or moderate speeds. Suitable for all kinds of pumps, blowers, compressors and other mechanical drives.



Multi-Stage With Separate Gear. Like all Worthington Multi-Stage Turbines, these are available in all types and are readily adaptable to special applications. Recommended for driving low speed equipment such as condenser circulating pumps, water supply pumps, etc.



High Back Pressure. Can be supplied in either single or multi-stage type for exhaust pressures up to 250 lbs.

For Low-Cost, Dependable Power. Check fully on the many advantages of Worthington Turbines. You'll discover what users the world over already know — that *there's more worth in Worthington*. Contact your nearest Worthington representative or district office, or write direct to *Worthington Pump and Machinery Corporation, Steam Turbine Division, Wellsville, N. Y.*

WORTHINGTON

STEAM TURBINES

TD-1

A GREAT TEAM IN STEAM

Feed Water Heaters

Multi-Stage Turbines

Boiler Feed Pumps

Turbine-Generator Sets

Single-Stage Turbines

Surface Condensers

NEW EQUIPMENT and Manufacturers' Literature

For copies of manufacturers' literature or more information about products described on these pages use the coupon below, circling the number shown for each item desired. Or write the manufacturer direct to address as shown.

1. Agitation Mixer

Up to 16 standard fluid agitation speeds are obtainable with a new heavy duty Lightnin mixer developed by Mixing Equipment Company, Inc., Rochester, N. Y. Sizes are from one to 500 hp and most models operate at any one of 16 standard AGMA output speeds, ranging from 16.5 to 420 rpm. Speed is changed by removing the cover plate and replacing the two gears with a different pair, supplied by the manufacturer, see picture. The change from one operating speed is made quickly without dismantling the unit or removing it from tank, and in most cases without even disconnecting the motor. Other features include: independent shaft suspension, interchangeable mounting brackets, and standard interchangeable impeller construction, with a wide choice of impeller shapes and sizes.

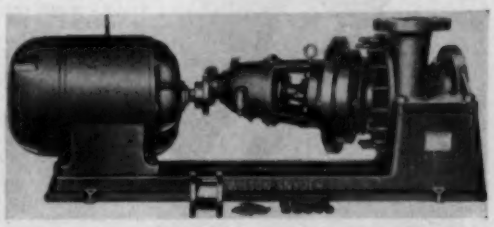
2. Delayed Coking

"New Horizons—Lummus at Pan-Am Southern," a brochure published by The Lummus Company, 385 Madison Avenue, New York 17, covers the delayed coking process generally while using Pam-Am Southern Corporation's El Dorado, Ark., unit as example. The economics and processing significance of delayed coking is discussed and a flow diagram of the Pan-Am Southern unit, including operating data, is reproduced. Sequence photographs which present each step in the coke making and handling cycle at El Dorado are included.

3. Signal Bells

Signal Engineering & Manufacturing Company, 154 West 14th Street, New York 11, features Explosion-Proof Bells in their latest bulletin. Operational and constructional features, design and assembly detail, underwriters approvals, and ordering information are among the subjects covered. Sectional views of various types are shown.

4. Centrifugal Pumps



Two new models have been added to the line of centrifugal pumps manufactured by the Wilson-Snyder Manufacturing Division, Braddock, Pa., of Oil Well Supply Company. Type ES, which is illustrated, is designed for various process applications where continuity of operation is important—temperature or pressure may be very high—hot or cold liquids are handled near their boiling points, and broad capacity range at high efficiency is desirable. The illustration shows the ease with which the pump can be dismantled for inspection without disturbing the piping or driver. Twelve pump sizes with 22 impeller designs provide operating ranges from 40 to 1500 gpm. with differential heads from 40 to 1000 feet and speeds from 1750 to 4000 rpm. Type CS is a single-stage centrifugal recommended by the manufacturer for general service applications which call for dependability, strength and effciency at minimum cost. Six sizes provide overall operating ranges of: capacities from 10 to 550 gpm. differential heads from 15 to 160 feet, and speeds from 1750 to 3500 rpm.

5. Hand Barrel Truck

New convenience in handling barrels is the Liftomatic Materials Handling Truck manufactured by Marvel Industries, Inc., 5154 West Church Street, Skokie, Ill. The barrel is engaged and carried by two jaws (see picture) which close on the upper rim and carry the entire weight as there is no flooring to the truck. The truck handles either steel or

FOR ADDITIONAL INFORMATION on products and literature mentioned in this section write the manufacturer direct or circle item numbers, cut out and mail this coupon. Prompt action is suggested so that data will be forthcoming without delay.

PETROLEUM REFINER
BOX 2608, HOUSTON 1, TEXAS

Please have manufacturers send me, without obligation, additional information about items from July, 1951, New Equipment Section whose numbers are circled below:

1	2	3	4	5	6	7	8	9	10	11	12
13	14	15	16	17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32	33	34	35	36
37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57			

Name_____ Title_____

Company_____

Street address_____

City and State_____

PLEASE PRINT OR TYPE YOUR COMPLETE MAILING ADDRESS

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

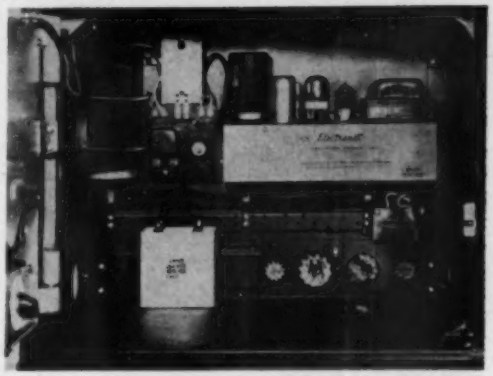
fiber drums, and is especially adaptable to fiber drums. Lack of flooring permits the operator to release the barrel in the exact spot where the barrel is to be placed by merely releasing the grip on the lid. The jaws operate on a sliding unit permitting the operator to lift any size barrel directly from the floor. Built of heavy welded steel, the truck weighs 45 pounds and is capable of carrying capacity loads. Comes in two wheel sizes, full roller bearings, and mounted on heavy duty, neoprene rubber tires. Distributed by H & N Sales Engineering Company, 3217 South Main Street, Houston.

6. Single Seated Valves

Valve Catalog 1500 B, issued by The Annin Company, 3500 Union Pacific Avenue, Los Angeles 23, describes in detail the operation and performance of Annin single seated valves, the Domotor, electro-pneumatic, handwheel and combination valves. Optional assemblies for specialized applications are shown. Annin valves are applicable to most of the complex control problems commonly encountered in the processing industries, according to the company. They are designed to accurately control hot or cold fluids of all types, including errosive and corrosive types. Available in a range of alloy construction material in line sizes from ¼ up to 6 inches in series 15 through 60. Catalog.

7. Pen Recorder

A new electronic, high-speed pen recorder for measuring rapidly changing variables experienced in laboratory and test applications is made by Minneapolis-Honeywell Regulator Company. Full-scale signals which vary as rapidly as 20 cycles a minute can be recorded on the new model, also those with peak-to-peak amplitude of ten percent of scale which vary as rapidly as three cycles a second. The "recorder will provide accurate recording in rocket engine testing where thrust of the engine is measured with a strain gauge." The pen recorder is applicable for spectrographic and other analyses where relatively high scanning rates and narrow increments of change are encountered in a measured variable.



8. Enclosed Motors

Allis-Chalmers Mfg. Co., Milwaukee, Wis., has released a bulletin on types of construction and ratings of its improved totally-enclosed, fan-cooled motors with tube-type, air-to-air heat exchangers. A chart showing ratings of the motors, available in squirrel-cage, wound-rotor and synchronous types for both horizontal and vertical installation, also gives a cross section view of the horizontal motor construction features. These features include capsule-type bearings, protected air intakes, and pipe-plug protected, tapped holes for checking air gasp with feeler gauges.

9. Adsorption Fractionation

A new method of adsorption fractionation has been developed by Burrell Corporation, 2223 Fifth Avenue, Pittsburgh 19. The self-contained piece of laboratory apparatus separates, identifies and measures by volume of separated fractions any contacting gas. Identification is made by measurement of the thermal conductivities and the volume of each fraction is arrived at by determining the change in pressure of an evacuated system. Identifications and measurements of the gas fractions are recorded on a potentiometer to give a complete and automatic record of each analysis. An electrical connection and approximately 300 milliliters of sample are all that is required for operation of the equipment which measures 3 x 2 x 6 feet.

10. Transmission Drives

Information on the new HY-VO power transmission drives manufactured by Morse Chain Company, 7601 Central Avenue, Detroit 8, is given in catalog Number C 72-51. Data discussed includes operating principles, highlights of design principles, performance capacity, and installation and lubrication procedures.

11. Panel Controls

Lower operating expense and reduced space requirements are improvements claimed by Bailey Meter Company, 1050

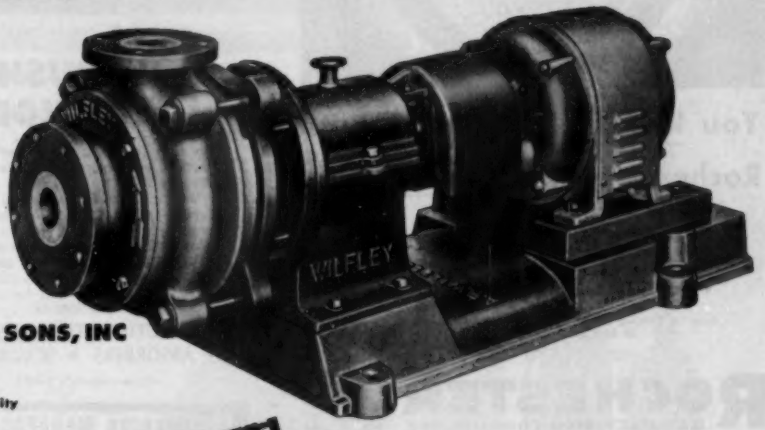
More Data — and Fast!

For additional information on New Equipment items or literature mentioned in this section, use the coupon on reverse side. Or write to manufacturer direct at address shown.

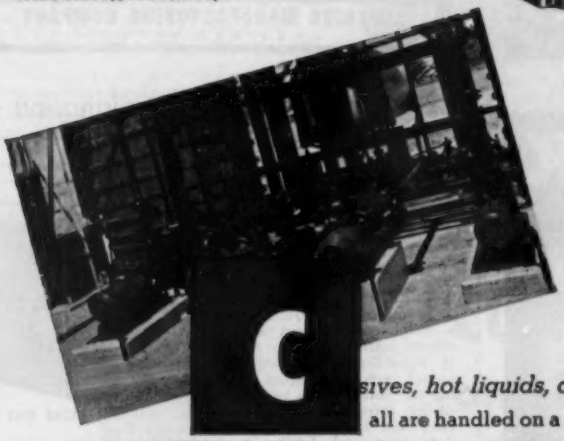
Act today!

cupric chloride

BUY WILFLEY FOR COST-SAVING PERFORMANCE



A. R. WILFLEY & SONS, INC
Denver, Colo., U.S.A.
New York Office:
1775 Broadway, New York City



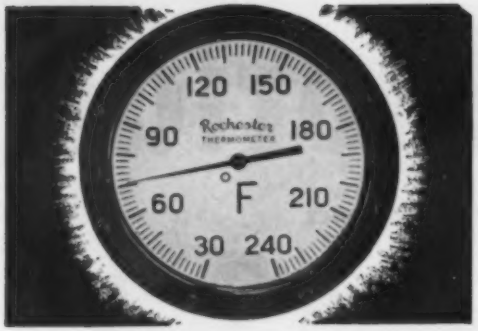
A leading Rocky Mountain refinery uses these two Wilfley plastic lined acid pumps for cupric chloride service in their gasoline sweetening process. Performance is continuous; efficiency is high. Wetted pump parts feature extra long life.

C

sives, hot liquids, acids and mild abrasives... all are handled on a continuous, trouble-free schedule by WILFLEY Acid Pumps. Actual production records of chemical plants all over the world prove the high efficiency, dependability, and substantial savings in operating costs of these famous pumps.

Available in 10- to 2,000-G.P.M. capacities; 15- to 150-ft. heads and higher. Individual engineering on every application. *Write or wire for details.*

WILFLEY *Acid* PUMPS



You know at a glance with

Rochester DIAL THERMOMETERS

- LARGE, EASY TO READ DIALS
- FAST AND ACCURATE
- RUGGED, STURDY CONSTRUCTION
- CORROSION-RESISTANT STAINLESS STEEL
- 35 YEARS MANUFACTURING EXPERIENCE

Send for Catalog No. IT-650, Rochester Manufacturing Co., Inc.
38 Rockwood St., Rochester 10, N. Y.

ROCHESTER
MANUFACTURING COMPANY, INC.
DIAL THERMOMETERS GAUGES AMMETERS

ROCHESTER GAUGES

KILLARK

Explosion proof lights

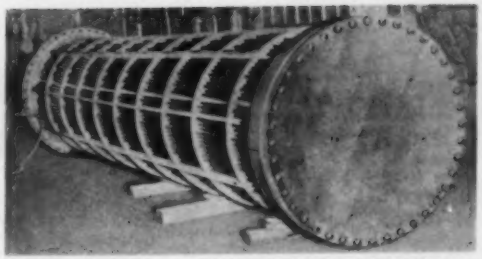
a safe answer for hazardous locations

Wherever inflammables or explosives are handled. Made of Die-Cast ALUMALLOY to combine safety, compactness, and strength. Special heat-resisting glass globe has safety factor of four to withstand internal explosions. Easy to relamp. Sizes: 60W to 500W, in ceiling, bracket and pendant types. Explosion proof junction boxes, switches, and fittings are also manufactured by Killark.

Killark *Write for Illustrated Literature*

ELECTRIC MANUFACTURING COMPANY

Vandeventer and Easton Aves. St. Louis 13, Mo.



Superior built 48" heat exchanger with 22,000 ft. of ¾" tubing.

ON RUSH JOBS—
NO HOLD-UP!

On rush jobs you cut downtime cost with SUPERIOR'S prompt retubing service because SUPERIOR saves you every minute.

And you have no hold-up in putting new units into service when SUPERIOR builds your new heat exchangers.

Our engineers welcome the opportunity to discuss your problems. Call, write or wire TODAY for information or estimates.

FABRICATORS OF
- FRACTIONATING TOWERS
- ABSORBERS • SCRUBBERS

Phone—Amarillo 3-4395

API-ASME AND ASME CODE
CERTIFIED BY NATIONAL BOARD

SUPERIOR MANUFACTURING COMPANY
AMARILLO, TEXAS

Bringing you a clear explanation of

LIQUID EXTRACTION...theory...equipment ...processes used in industry

for practical application in separating components of solutions

JUST OUT

HERE, for chemists, chemical engineers, and others in the chemical industry, is a complete review and organization of the subject matter related to the unit operation of liquid-liquid extraction. Sets forth the known facts about liquid extraction, outlining the potentialities and limitations of applying extraction to separation problems. Correlates hitherto apparently unrelated data; gives detailed references to many original sources; includes essential equations and many illustrative examples to insure understanding of all important phases of liquid extraction.

LIQUID EXTRACTION

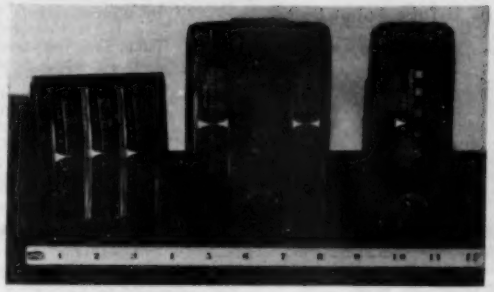
BY ROBERT E. TREYBAL
Prof. of Chemical Engineering, N.Y.U.
422 pages, 6 x 9, 265 illus., $7.50

Check this sampling of the numerous subjects covered in the book:

- nozzles and orifices
- use of jets
- refining indices
- stability of emulsions
- complex liquid-liquid equilibria
- stage efficiency
- sweetening processes
- solvent recovery
- etc.

Send orders to
The Gulf Publishing Company
P. O. Box 2608 • Houston, Texas

Ivanhoe Road, Cleveland 10, for their new Mini-Line. Information and controls for operating one or more boilers, turbines, or process units are concentrated in a space that is up to 87 percent smaller than usual on Mini-Line equipment. The three units introduced are: multi point indicator, selector valve, and a remote manual relay. Wherever possible the manufacturer prefers to mount the Mini-Line instruments on a console type centralized control panel. The Mini-Line control panel may be entirely automatic, or individual units or entire systems may be controlled manually from relays.



12. Surge Control

An industrial bulletin dealing with the problem of surge control in gas and air piping as well as a consultation and design service in compressible fluid surge control is offered by the Burgess-Manning Company, Petroleum-Chemical Headquarters, 1203 Dragon Street, Dallas. The advisory group is headed by R. L. Leadbetter, vice president of the company; A. P. Gallagher, applications engineer; and W. C. Vack, design engineer. The bulletin deals with the pulsating flow of compressible fluids in pipe lines as a problem of dynamics that can be controlled by the application of "snubbers".

13. Industrial Equipment

Bulletin Q-14 "Elliott Equipment for Power Plant and Industry" has just been released by Elliott Company, Jeannette, Pa. Well illustrated, this booklet reviews the Elliott line and describes briefly the major steam and electrical products of the five Elliott plants. Material is organized into two sections covering steam and related equipment and rotating electrical equipment.

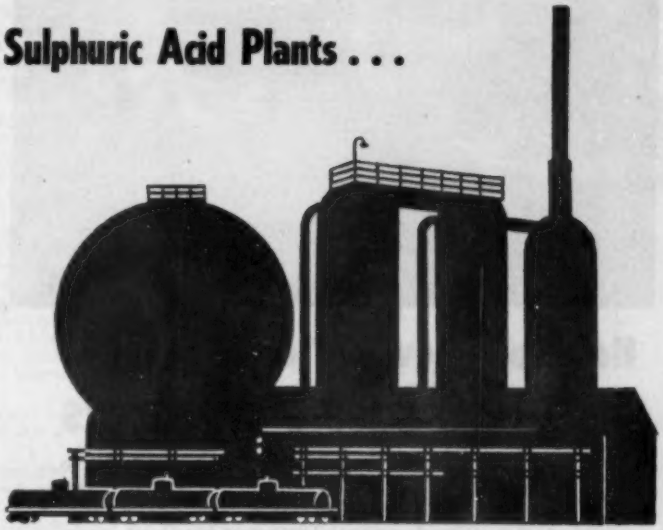
14. U-Bend Pullers

A new hydraulic U-bender puller has been designed and is made by Key Company, 2605 McCasland Avenue, East St. Louis, Ill., because the return bend fittings on the old models were being damaged when taken down for cleaning and inspection. The hydraulic U-bend puller for Key Type 3600 fittings is said to reduce maintenance time, to eliminate damage to fillings caused by heating and sledging. It is claimed to have the added safety feature of preventing U-bends from falling out of fittings when suddenly released. "Simple and rugged, it is easy to operate." One assembly can be used for a combination of fitting sizes and centers.

15. Driven Compressors

Bulletin No. 113 issued by Clark Brothers Company, Inc., Olean, N. Y., describes Model HLA, 17-inch by 19-

Sulphuric Acid Plants . . .



CONCENTRATORS
and Recovery Plants

Nicolay Titlestad Corp. offers a specialized engineering service for those seeking experience, initiative, and engineering in building, or modernizing acid plants and concentrators of all types and sizes.

Inquiries invited. No obligation.

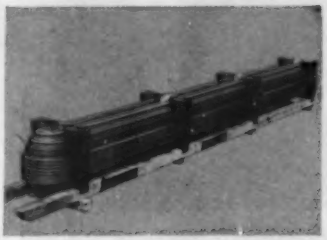
NICOLAY TITLESTAD
CORPORATION
11 West 42nd Street **New York 18, N. Y.**

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

inch gas-engine-driven compressor. The HLA delivers 250 bhp. per power cylinder at 300 rpm. Four models are available: 5, 6, 8 and 10 cylinders with 1250, 1500, 2000 and 2500 bhp. respectively. Many of the HBA and HLA parts are interchangeable. Clark reports it has incorporated all time-tried field proved high compression and precision features of the HBA into the HLA. The new model is recommended for gas transmission pipe line use, for natural gasoline plants, gas utilities and various other services.

16. U-Tube Pallet Unit



A method of packaging U-bend tubes for head exchangers has been developed by Wolverine Tube Division of Calumet and Hecla Consolidated Copper Company, Inc., 1850 Guardian Building, Detroit 26, which permits direct installation from shipping pallet-to-condenser on receipt at the customer's plant. The idea is to nest U-tubes according to the customer's prints, and palletize them at Wolverine plants. This permits the movement of the condenser tubes directly from the shipping pallet into the heat exchanger or condenser.

17. Radiation Meter

"Cutie Pie" is what Tracerlab, Inc., 130 High Street, Boston 10, has dubbed a portable radiation survey meter which is useful in measuring beta and gamma radiation in "hot" laboratories handling levels of radioactivity of the order of millicuries. A new circuit designed in cooperation with the National Research Council of Canada at Chalk River, makes use of the principle of inverse feed-back, permitting stable operation and a large reduction in the time constant which is now only 1.5 seconds on all ranges. The SU-1E radiation survey meter has three full scale ranges of 15, 150 and 1500 mr/hr. Gun-shaped, the instrument is handy for getting into inaccessible places.

18. Air-Fuel Controller

An air-fuel ratio controller manufactured by Leeds & Northrup Company, 4934 Stenton Avenue, Philadelphia 44, Penn., adjusts air flow to fuel flow changes rapidly, yet without cycling, according to the manufacturer. Applicable to oil or gas firing, it meters both fuel and air flow for maximum accuracy of control. Available for use where ratio control alone is desired, this instrument is a component of L&N Integrated Control of temperature, draft and combustion of large fuel-fired furnaces and kilns. Models are available for either electric or pneumatic control valve. The controller comes in a single instrument case which fits into standard panel cutouts. Ratio range extends from 50 percent deficiency to 100 percent excess air.

19. Draft Instruments

A functionally designed fully indexed bulletin on its line of draft and low pressure instruments is offered by The Hays Corporation, Michigan City, Ind. The bulletin discusses indicators, recorders, and controllers. A two-page application table is included to aid the reader in selecting the correct instrument for specific conditions. Features

How to renew old drums in just 7 minutes

THAT'S right! Used drums restored to like-new condition . . . cleaned, paint-stripped, rinsed, dried, and repainted—in just 7 minutes! That's how fast Oakite cleaning works in one barrel-house.

Reconditioning barrels and drums the Oakite way has these extra advantages: Fewer rejects . . . more uniform paint stripping . . . better adhesion for new paint. Elimination of paint build-up on steam coils . . . no clogging of drains and sewers.

Your Oakite Petroleum Service Representative will gladly help you get better, faster drum-conditioning. Call him today.

FREE BOOKLET F7629 tells all about drum-conditioning—tells how to save time and money on other big cleaning jobs. Write Oakite Products, Inc., 50D Thames St., New York 6, N. Y.

Technical Service Representatives Located in Principal Cities of United States and Canada

OAKITE
PETROLEUM SERVICE DIVISION

Refinery Expansion by Million Barrels Daily Held U. S. Need

Special to THE WALL STREET JOURNAL

SAN ANTONIO — The nation must add 700,000 barrels a day to its basic crude oil refining capacity by the end of 1952 and a million barrels by the end of 1953.

Bruce K. Brown, deputy administrator of the Petroleum Administration for Defense, brought this measure to the Western Petroleum Refiners Association in convention here yesterday.

By the end of 1956, Mr. Brown said, new basic refining capacity must exceed 1,600,000 barrels a day. If possible, he said, these goals will be reached without recourse to special loans under the Defense Production Act or to government-owned plants. New construction will be encouraged by tax amortization and material priorities.

Basic refining projects already approved from the standpoint of tax certification, the deputy administrator noted, will require the investment of $318 million of private funds and will increase national petroleum refining capacity by 370,000 barrels a day.

"Unless and until P. A. D. is convinced the necessary expansion of basic refining capacity cannot be accomplished by normal methods," Mr. Brown declared, "it will not recommend special loans under the provision of the Defense Production Act. Such taxpayers' money as is available should, we believe, be used for necessary projects which offer smaller hope of attainment by normal methods of finance."

Mr. Brown added the goals he named for the next few years "may be insufficient if international tensions increase."

Besides finished products of the type normally needed, Mr. Brown said: "There is also a highly pressing need to increase our capacity to produce special military products, such as jet fuel and aviation gasoline, and to produce critically needed products such as benzene." Such production, he noted, is dependent on the desired increase in basic capacity, however.

At present, he said, there is a special need for greater dispersal of refineries into safe interior locations.

REFINERY EXPANSION by 1,000,000 BARRELS DAILY is NATION'S NEED...

"The nation must add 700,000 barrels a day to its basic crude oil refining capacity by the end of 1952 and a million barrels by the end of 1953." So states the article on the left.

WHAT DOES THIS MEAN TO YOU? HOW MUCH CAN YOU INCREASE YOUR PRESENT CAPACITY?

If, after giving that some thought, you cannot arrive at a satisfactory answer, your best solution is to call REFINERY ENGINEERING Company. Treco is geared to deliver a complete refinery service including:

- *Economic Studies* — reports on operating cost, yields and profits on any proposed construction. Determination of proper type of plant to give you quickest realization of profit and highest return on investment.
- *Analysis* — of space and facility requirements, site selection, appraisal and project organization.
- *Design* — Before any phase of drafting is done, Treco's Process, Mechanical, Electrical and Civil Engineers have assembled and coordinated all necessary data bearing upon the satisfactory completion of any planned construction. Treco's drafting department can then quickly and unerringly complete the plans with assurance that every factor, bearing on the economical and profitable operation of the plant, has been incorporated.
- *Construction* — Treco maintains an abundance of heavy equipment, sufficient for the largest and most complicated construction job. Heavy rigging and erection work have long been a specialty with our organization and trained crews, who know their business, assure that your plant can be "on stream" in the minimum time.

Contact REFINERY ENGINEERING Company NOW. Learn how Treco can help you to greater, more economical production in 1952, 1953 and the years to follow. Naturally, this will not obligate you in any manner.

TRECO

REFINERY ENGINEERING Company

PHONE 5-5561 • TULSA, OKLAHOMA

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

such as calibrating springs, diaphragm units, and differential valve assemblies are explained. Size, scales, ranges, cases, etc., of each instrument are illustrated and discussed. Bulletin 51-667.

20. Diaphragm Motor Valves

Specification sheets covering theory, applications and engineering data on deluxe and medium-priced models of three-way control valves have been published by Brown Instruments Division, Station 40, Minneapolis-Honeywell Regulator Company, Wayne and Windrim Avenues, Philadelphia 44. Mixing and diverting services for which three-way valves are employed as well as type of disc and mode of control used for these services are described. Technical data on materials, body pressure ratings, maximum differential pressure or drop and flow-lift characteristic charts are included. Specification Sheet No. 416-1.

21. Spray Nozzles

Spray Nozzles for water cooling, air conditioning and for general industrial uses are discussed in the new Yarnall-Waring Company, Mermaid Lane, Philadelphia 18, booklet. Specifications and illustrations of spray nozzles as well as listed advantages and uses. Factors of recooling water are reviewed and equipment for cooling ponds is discussed.

for the REFINERIES and PETRO•CHEMICAL PLANTS of the GULF COAST

We offer a highly specialized manufacturing service to meet your needs for...

- LACQUERS and
- INDUSTRIAL FINISHES

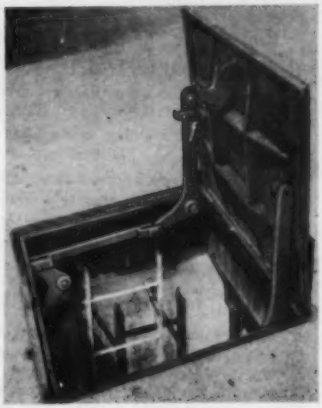
Our intimate contact with the huge chemical plants of the Gulf Coast enables us to serve the petroleum industry more effectively and economically. May we discuss your needs?

CPL

COAST Paint & Lacquer Co. Inc.

P. O. BOX 1113, HOUSTON 1, TEXAS

22. Vault or Manhole Cover



The Safety Counterbalanced Vault or Manhole Cover made by The E. H. Wachs Company, 1527 N. Dayton Street, Chicago 22, utilizes carefully designed counterbalances for one-handed operation in lifting the cover to vertical open position. Because of the counterweights, the cover will not slam down; when closed it can be opened from inside the vault by one man. The "tamper proof" lock cannot be opened without the key-handle. The counter balance structure protrudes less than six inches from the wall, and has a 30-inch square opening. Made with a heavy duty cast iron frame and ribbed steel cover machined for accurate rattle proof fit, the cover is recommended by manufacturer for use with valve, meter, transformer, or any underground vaults.

23. Radiation Detector

A specific for routine contamination check in radioactivity laboratories, the SU-3B laboratory monitor manufactured by Tracerlab, Inc., 130 High Street, Boston 10, is a direct reading, a.c. operated, instrument having three full-scale meter ranges of 200, 2000 and 20,000 counts per minute. It comes completely equipped, including a mica end-window Geiger tube, enclosed in a detachable probe assembly connected to the instrument by a convenient length of flexible cable. Weighing 17 pounds, the monitor is cased in a walnut cabinet and has a clip at the left for holding the Geiger tube horizontally near the table top when not "exploring" with the probe.

24. Desulfurizer

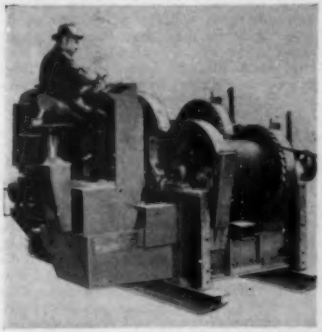
"Solve Your 'Sour' Gas Problem" is the title of a bulletin issued by Black, Sivalls & Bryson, Inc., 7500 East 12 Street, Kansas City 3, Mo., to publish information on what the BS&B Desulfurizer is and how it works. The middle spread is a fold-over diagramatic drawing of a complete desulfurizing hook up. It also includes notes on operating data as well as factors to consider when selecting a desulfurizing unit. Bulletin.

25. Insulation

A new catalog prepared by Refractory & Insulation Corporation, 120 Wall Street, New York 5, explains where, when and how to use refractory and insulating materials of various types in

industrial heat processing and heat generating equipment of all kinds. Subject material covers cements, brickwork, chrome, and such specialties as molding mix, gun cement, baffle mix, etc. Among building materials described are plastic fire brick, insulating block, wool blanket insulation, plastic insulation, and other insulating requirements.

26. Steel Erection Hoist



"Iron Workers' Special," a hoist manufactured by American Hoist & Derrick Company, St. Paul, Minn., is said to get positive load control through a torque converter, anti-friction bearings, and air operated, contracting type tandem band clutches which permit an operator to "feel" his load into position accurately and smoothly. Brake linkage between foot pedals and contracting bands is anti-friction bearing mounted for easy operation. Safety features include a back-up brake that engages automatically on reversal of the drive shaft, ratchet rings of forged steel with compression type dogs and overload regulating air valves which permit clutch slippage in case loads become "snagged" or "hung up" while being hoisted. Basically a two-drum hoist, it will handle three if desired. Three models are available in a range from 14,000 pounds to 25,000 pounds with single line pull.

27. Combustion Meters

The Hays Combustion Meter, or CO_2 Recorder, manufactured by The Hays Corporation, Michigan City, Ind., is a guide index to the efficiency of any fuel burning operation and operates on the Orsat principle of volumetric measurement and chemical absorption to analyze combustion gases. The method is to trap and measure a sample of flue gas and then to pass it through an absorbing chemical which removes the carbon dioxide component of the gas mixture. After absorption, the sample is again measured and its volume compared to the original sample. The difference before and after absorption gives the exact percentage of carbon dioxide absorbed by the chemical. This is recorded on the chart at the end of each analysis which is about every two minutes.

28. Rollo Valves

Worthington Rollo Valves, shown in Bulletin W-404-B4, discusses the valve features offered by Worthington Pump and Machinery Corporation, Harrison, N. J., for use with viscous liquids, and liquids with solids. The Rollo valve cover is heavily constructed of drop-forged carbon steel and acts as spring retainer and stop for valve. The Rollo spring is corrosion resistant 18-8 stainless steel, ground flat on the ends. The Rollo valve is drop-forged 11-13 percent chrome alloy steel, hardened to 325-360 Brinell. Face is spherically ground for line contact with seat. The Rollo valve seat is same as for Worthington Wing Valves.

29. Gate Valves

"Cast Carbon Steel Gate Valves" is a new catalog put out by Pacific Valves, Inc., 3201 Walnut Avenue, Long Beach 7, Calif., to explain their line of small size merchandise. Included in the catalog are 600 pound O. S. & Y., Bolted Bonnet, ½ to 2 inches; O. S. & Y., Union Bonnet, ½ to 2 inches; Inside Screw, Union Bonnet, ¼ to 2 inches, as well as engineering data, dimensions, materials and list prices. Catalog.

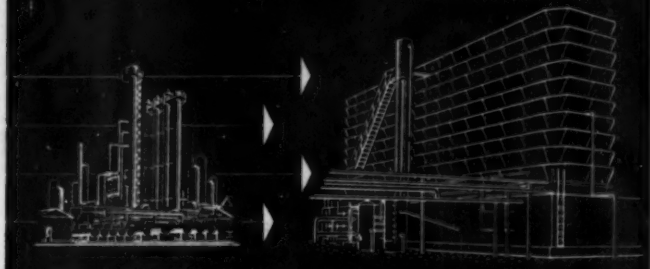
New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

30. Miniature Geiger Counter

The "Snooper", a low-priced Geiger Counter which weighs only 1¼ pounds, is manufactured by Precision Radiation Instruments, Inc., 4113 West Jefferson

HOW TO LICK YOUR



Cooling Water Problem

Water is the most common and widely used raw material. However, its use can... and usually does... pose an infinite variety of non-identical problems. Variables include the water itself, the plant equipment, operating conditions and many other factors. The proper approach to the solution of a cooling water problem... whatever its nature... is to engage the service of specialists who provide an adequate and well-balanced program of scientific control.

BETZ is an organization of engineers and chemists specializing in the solution of all industrial water problems. Over two decades of experience have made BETZ water conditioning service scientifically correct, complete... economical. Our nationwide staff of engineers welcome the opportunity of discussing your water problems. W. H. & L. D. BETZ, Gillingham & Worth Streets, Philadelphia 24, Pa.

BETZ

COOLING WATER CONDITIONING • BOILER WATER CONDITIONING

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

Boulevard, Los Angeles 16. This miniature counter measures 1¼ by 3 by 5 inches and will fit into the palm of the hand. Simple to operate, it uses an ordinary flashlight battery for power, is supplied with an earphone, a radioactive sample and complete instructions. The miniature amplifier gives a loud signal when near radio-active material. The "Snooper" comes in a plastic case.

31. Pneumatic Standards

A booklet containing J. I. C. Pneumatic Standards for Industrial Equipment, recently adopted by the Joint Industry Conference on Pneumatics as the desirable quality requirements to be specified by users of pneumatic machinery and equipment, is offered as a service by Miller Motor Company, 4027 N. Kedzie Avenue, Chicago 18.

PATTERSON
Side Entering
AGITATORS
PATTERSON
PATTERSON MACHINERY
in types and sizes
for every refining need!
• Outside packed—without stopping unit. Dependable, trouble-free operation in V-belt or geared drives. Send for details.
Richard L. Conover
The Patterson Foundry and Machine Company
East Liverpool, Ohio, U. S. A.
NEW YORK, BOSTON, BALTIMORE, PHILADELPHIA, PITTSBURGH, DETROIT, CINCINNATI, CHICAGO, ST. LOUIS, HOUSTON, DENVER, LOS ANGELES, SAN FRANCISCO, SEATTLE
The Patterson Foundry and Machine Company, (Canada) Limited
Toronto, Canada
MONTREAL

32. Fire Killing Foam

Aer-O-Foam 99, a liquid type mechanical foam for use on fires involving polar solvents or petroleum products is marketed by the National Foam System, Inc., West Chester, Pa. In demonstrations, National Foam officials said, Aer-O-Foam provided a smothering, close-knit blanket of fire-killing foam and did not readily break down or disintegrate on fires involving methyl, ethyl, isopropyl alcohols, esters, ketones and ethers as well as petroleum products. It is claimed that once the foam mass is broken, it quickly reseals and the foam spreads across flaming fluid smothering flames completely, and making reignition impossible.

33. Welding Fittings

Bonney WeldOlets is the newest catalog published by Bonney Forge & Tool Works, Allentown, Pa. The illustrated booklet contains information on trade practices, descriptions of WeldOlets, butt-welding, ThreadOlets, WeldOlets, and socket welding. Further sections contain installation instructions and diagrams illustrating sectional views of WeldOlet, butt-welding properly attached to run pipe, as well as complete technical treatment of such data as code and design, T-P ratings, material specifications, etc. Catalog Number W-3.

34. Heavy Duty Thermometer

A new all-purpose thermometer protected by a welded stainless steel case is made by Tagliabue Instruments Division, Weston Electrical Instrument Corporation, 614 Frelinghuysen Avenue, Newark 5, N. J. The new thermometer, TAG Model 8689, incorporates heavy, corrosion-resistant stainless sheet steel in functional design for use in any weather conditions. The scale is large, clear, and ranges from minue 40° F. to 400° F. Arched "bows" and flanged edges of the case provide wide angle vision; wide open spaces around the bulb ensure maximum air circulation for true readings. A special feature is the removable scale and tube unit for easy replacement in case of breakage.

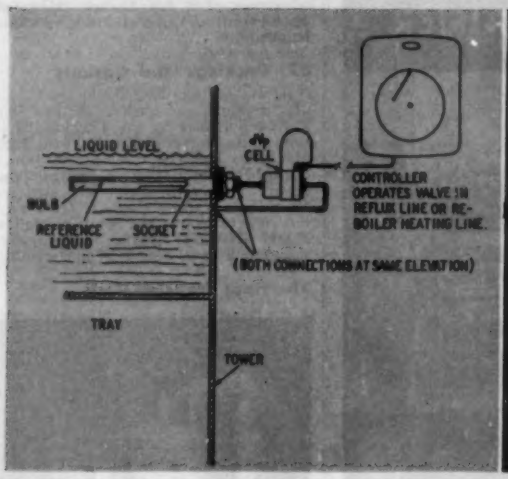
35. Core Knockout

Photos and line drawings illustrate core knockout and casting cleaning in a Pangborn Corporation, Hagerstown, Md., booklet on "Hydro-sand Blast and Core Knockout; Custom and Unit Type Installations." Hydro-sand Blast specifications are listed and operations are discussed in relation to both foundry and oil fields. Also included is a schematic drawing of a typical installation before and after core knockout and cleaning, illustrating Hydro-sand Blast in operation.

36. Potentiometer

The new Brown ElectroniK Strip Chart Pneumatic Control Potentiometer manufactured by Brown Instruments Division of Minneapolis-Honeywell Regulator Company, Wayne and Windrim Avenues, Philadelphia 44, combines the advantages of pneumatic control with the strip chart instrument. The electronic "Continuous Balance" operating principle of the Brown ElectroniK, in union with the latest pneumatic control mechanism, the Air-O-Line, is said to provide an accurate and responsive instrument that possesses a simplicity and

For the first time!



CONTINUOUS CONTROL OF VAPOR PRESSURE

with the new, exclusive Foxboro dVp Cell

This revolutionary development by Foxboro introduces new simplification in distillation processes. Automatically measuring and transmitting vapor pressure *differential*, it eliminates time-consuming laboratory analyses in fractionating tower operation . . . permits tapping off fractions of any desired vapor pressure, within precise tolerances, continuously and automatically.

In the dVp Cell, the vapor pressure at any specified point in the column is continuously compared with the vapor pressure of a sample of the material desired at that point. The sample is contained in a bulb immersed in the liquid. The dVp Cell measures the difference between the two vapor pressures and transmits this difference to an automatic controller on the process. Changes in temperature affect product and sample equally, and hence have no effect on the differential measurement.

Detecting small pressure differences accurately, the new dVp Cell is not injured by high unbalanced pressures. It uses no mercury, is compact and easy to install. Self-contained manifold permits quick, easy filling of sample bulb with the reference fluid without special equipment, and without disassembly of the cell.

Write for detailed information on this unique new Foxboro development. Inquiries concerning unusual or experimental applications especially invited. **The Foxboro Company, 746 Neponset Ave., Foxboro, Mass., U.S.A.**

FOXBORO
REG. U. S. PAT. OFF.

RECORDING · CONTROLLING · INDICATING
INSTRUMENTS

107,000 Bbls. OIL WASTE WATER TREATED DAILY BY SINGLE HARDINGE CLARIFIER

TOTAL COST—½ MILL PER BBL.

This 57' x 150' Hardinge Rectangular Clarifier is treating 107,000 barrels of waste water daily–removing the floating oil and solids at a total operating cost of one-half mill per barrel, or 0.0012 cents per gallon. Approximately 50 barrels of oil per day are recovered.

The influent contains 3 to 5 milliliters per liter while the effluent tests show two-tenths to four-tenths milliliters per liter. Waste is treated with 25 to 45 p.p.m. aluminum sulphate and 5 to 9 p.p.m. activated silica.

Operating costs include labor, chemicals, repair, maintenance, taxes and utilities.

This is but one of the many installations where Hardinge equipment is playing an important part in the ever-growing waste treatment picture. Write us about your waste treatment problem today.

HARDINGE
COMPANY, INCORPORATED

YORK, PENNSYLVANIA—240 Arch St. Main Office and Works

NEW YORK 17 • SAN FRANCISCO 11 • CHICAGO 6 • HIBBING, MINN. • TORONTO 1
122 E. 42nd St. 24 California St. 205 W. Wacker Dr. 2016 First Ave. 200 Bay St.

New Equipment

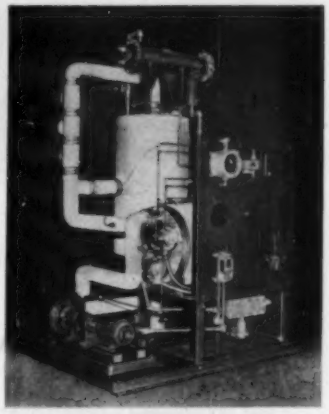
(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

fineness of full automatic operation. The strip chart type controller contains the advantage of a full 11-inch calibrated chart width and over 120 feet of chart length.

37. Packings and Gaskets

A catalog describing the 95 most popular packings and gaskets in their line has been issued by the Packing Division of Raybestos-Manhattan, Inc., Manheim, Pa. The catalog furnishes complete description of construction, service recommendations and size information on each item. A feature of this new catalog is the recommendation charts showing specific recommendations for a wide variety of applications.

38. Heat Transfer Units



The new standard line of electrically heated Dowtherm heat transfer units offered by Struthers Wells Corporation, Warren, Pa., is supplied complete with instruments, piping, insulation and other accessories, and is ready for immediate use upon delivery. Capacities range from 100-500,000 Btu.'s per hour, and temperatures range to about 750° F. using Dowtherm as a liquid or vapor medium. For further description refer to page 212 in the June issue.

39. Radiators Catalog

Young Radiator Company, Racine, Wis., and Mattoon, Ill., has available a new company catalog, No. 1651, covering its line of "Mono-Weld" radiators which shows the design features and accessories for both the one-piece and sectional-type cores. One-piece "Mono-Weld" radiators are available in various sizes capable of dissipating from 70,000 to 80,000 Btu. per hour under standard conditions. The sectional-type core units are of larger size ranging in capacity from 960,000 to 3,250,000 Btu. per hour.

40. Cellular Rubber

Rubatex, closed cellular rubber, is described in a new catalog put out by

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

Rubatex Division of Great American Industries, Inc., Bedford, Va. The manufacturer explains how the properties of Rubatex have been improved to meet the recently revised ASTM standards and methods of testing. Principal steps in manufacture are illustrated by photos. Rubatex is composed of minute individually sealed rubber-walled cells filled with inert nitrogen. It is claimed to be impervious to moisture.

41. Gaskets

United States Gasket Company, 602 North 10th Street, Camden, New Jersey, has published a new general catalog. The book is divided into two sections, the first covering Ajax spiral wound gaskets and a complete line of metal, metal-asbestos and cut gaskets from any material to standard sizes or to specifications. The second half of the catalog contains an introduction to Teflon, its properties and uses, followed by detailed information on the various Teflon products. Also included is a page outlining the Teflon products available. The catalog is illustrated with photographs and line drawings.

42. Aluminum Paint

Bulletin Number 536 describing MD 56 5W Aluminum Paste and its use in the pigmentation process of aluminum paints is issued by Metals Disintegrating Company, Inc., Elizabeth, N. J. Used for exterior painting "it yields whiter, brighter films with suppressed high-lighting and spotty glare, resulting in elimination of overlap marks and irregular checkerboard area patterns and on interior surfaces, it provides greater brightness." Manufacturer claims the greater degree of whiteness improves the appearance, maintains its color longer and so requires less frequent painting.

43. Mobile Fire-Fighters

A fire fighting trailer that carries 200 gallons of water right to the fire is the product of Preakness Engineering Company, 972 Broad Street, Newark 26, N. J. Described as intermediary between the hand extinguisher and the self propelled fire truck, the trailer is equipped with 300 feet of fire hose connected to a mono-type construction water tank integrally welded to the chassis. The water can be discharged in straight stream or water fog, or it can be used with a mechanical foam nozzle. The portable gasoline driven pump can be used to suck water through the suction hose from any water supply. Accessory

4 WAYS TO REDUCE PUMP REPAIRS

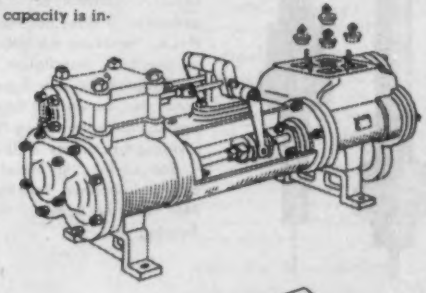
AND GAIN INCREASED EFFICIENCY

1 **Prevent STEM and SPRING breakage.** Exclusive double shock absorber built into Sims valves stops impact shock.

2 **Stop wear.** Long guide of ROTATOR prevents cocking of DISC—assures even opening. Rotator controls rotation of valve disc to increase service life—protect spring against crushing.

3 **Keep seating surfaces leak-free.** Only Sims guarantees the valve DISC will rotate every time it lifts. Does not hammer up and down on the same spot or require frequent replacement. You get three times longer wear from seat and disc—guaranteed.

4 **Stop valve slam and knock.** Quiet operation is gained by cushioning moving parts and cutting resistance to flow through the SEAT...with patented **inclined ribs.** This reduction of resistance allows cylinders to fill completely. Pump capacity is increased 20%.



Sims valves are made in sizes from 2¾" to 13¼" to fit any reciprocating pump. Valves supplied ready to install—cast in individual units or in complete plates.

NAME_____

TITLE_____

CO._____

ADDRESS_____

New catalog shows how Sims valves fit any pump—how they work—efficiency and comparison charts. Send for your free copy today.

SIMS PUMP VALVE CO., INC.

145 HUDSON ST., NEW YORK 13, N. Y. • M & M BLDG., HOUSTON, TEXAS

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

equipment includes nozzles, extension ladder, fire axe, portable extinguisher and suction strainer.

44. Plastic Packings

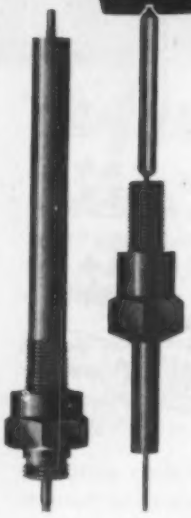
Plastic Packings are featured in a bulletin issued by the Packing Division of Raybestos-Manhattan, Inc., Manheim, Pa. The "versi-pak" non-jacketed plastic packings which the manufacturer claims is a dense, relatively inert packing with high compressibility that provides positive sealing at high pressures while maintaining relatively low pressure on the packing gland, is discussed. Made in two types, it is available in black with graphite for general use, and in white non-graphited form for use in food handling equipment and other special services. Description and service recommendations covering R-M Universal plastic packing is included.

45. Masonry Blades

"B-R" represents the break-resistant quality of an abrasive blade manufactured by Clipper Manufacturing Company of 2800 Warwick, Kansas City 8, Mo. It is claimed that dropping, twisting in the cut, or bending will not damage the new Clipper "B-R" blade. Manufactured in layers of glass fiber cloth impregnated with resins and silicon carbide, the material is then pressed under hydraulic pressure and processed in kilns where the temperature is scientifically controlled to insure a resilient and tough blade. Most effective performance is claimed in soft materials such as limestone, sandstone, light aggregate concrete products and dry press refractories, etc. Clipper Metal Bonded Diamond Blades are recommended for hard materials. The "B-R" is "especially adaptable for work where a true cutting level is impossible to maintain, causing the blade to bend or twist."

Total Cost—

... ONE BEARING!

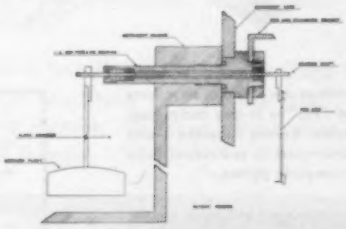


• Let this one I. I. C. Precision Bearing be all your cost. It's proved in the field in the most severe operating conditions in all types of mercury flow meters and controllers. It's the positive solution to leaking, freezing, corrosion and friction. The I. I. C. Non-Freezing Bearing is a sealed-pack unit and does not require lubrication at any time. The friction is reduced to a minimum, and remains constant at low or extreme high pressures. It does not require any shaft end thrust, therefore no adjustment is required at any time. Installation is simple.

Adapted for any type mercury meter or controller, as well as any special instrument application where long life, low friction and increased accuracy is desired.

For savings in initial cost, replacement and maintenance, specify the proved I. I. C. Non-Freezing Bearing. This is NOT a Teflon Bearing.

Above bearings are manufactured for Foxboro and Metric Meters. Bearings are also manufactured for all other type meters and controllers.



Visit the Sixth National Instrument Exhibit at the Sam Houston Coliseum in Houston, Texas, September 10-14, 1951. See our display in Booths 732 and 734.

IIC

INDUSTRIAL INSTRUMENT CORP.

P. O. BOX 1909 ODESSA, TEXAS

46. Turbines

Technical data for the vertical drive steam turbine have been compiled and issued in booklet form by The Whiton Machine Company, New London, Conn. This type drive is built in three general sizes, 14-inch rotor BTV, 24-inch rotor BKV, and 36-inch rotor BEV, handling industrial applications up to 600 hp. with thrust loads of 8000 pounds or more and steam conditions as high as 900 psig. and 900° F. total temperature. Booklet gives facts applicable to refineries, marine cargo, geared circulating and boiler feed pumps. Booklet VT351.

47. Packing Rings

Conclusions recently drawn by Raybestos-Manhattan engineers in tests performed at the Franklin Institute Laboratories are the text of the new R-M bulletin "Vee-Flex Packing Rings" by Raybestos-Manhattan, Inc., Manheim, Pa. Drawings show the photoelastic stresses produced with polarized light in two different types of rings, one with flat surfaces of conventional rings and one with the convexly curved surfaces used in the Vee-Flex ring.

48. Stainless Pipe

Data sheets giving pertinent information about Schedule 5 light wall stainless steel pipe are being printed by The Carpenter Steel Company, Alloy Tube Division, Union, N. J. Schedule 5 pipe recently was approved by the Correlating Comittee of the American Standards Association and is expected to fill the gap created by the short supply of nickel and other alloys formerly used.

49. Heat Insulation

"The Story of Kaylo" describing Kaylo calcium silicate products and their uses, is distributed by the Kaylo

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 297, or write manufacturer direct.)

Division of Owens-Illinois Glass Company, Toledo 1, Ohio. Contents cover research and development of hydrous calcium silicate products as well as description of properties and product uses. Illustrations show the fire resistant qualities of Kaylo laminated panels and firedoors.

50. Oil Combustion Systems

A new Peabody Engineering Corporation bulletin describing in detail the Peabody Constant Differential System for use on oil combustion installations has been published by Peabody Engineering Corporation, 580 Fifth Avenue, New York 19. Text contains information on the CD pump system and principles of control, the valve system, the straight mechanical burners, and the Peabody CD Pump system. It also contains the Southern California Edison chart. Bulletin 109-B.

51. Manual Valve

Barksdale Valves, 1566 East Slauson, Los Angeles 11, manual on 'Shear-Seal' valves covers the entire range of shut-off, selector, and manipulator valves for pressures from zero to 6000 psi. It contains explanatory copy and illustrations of the patented 'Shear Seal' principle: A pressure balanced, self aligning, tubular valve seat maintains intimate contact with an optically flat porting disc. Flow passages are opened or closed by the rotary movement of this disc. Fluid flow is always through the center of the 'Shear Seal' never across sealing surfaces.

52. Liquid Measuring Guide

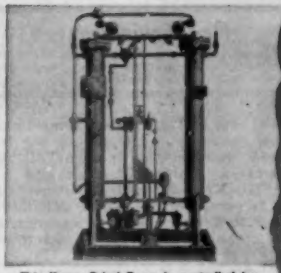
Bulletins intended to guide the selection of meters for measuring chemicals, petroleum products, and other liquids with varying corrosive characteristics are issued by Rockwell Manufacturing Company, 400 North Lexington Avenue, Pittsburgh. Rockwell industrial meters are built of a variety of metals and other materials and are assembled to specification depending upon service conditions. They range in size from one-half to three inches, measure in gallons, Imperial gallons, barrels, or liters, have totalizer capacity up to seven figures and are available in six types of registers. Industrial Meter Bulletin No. OG400.

53. CO_2 Recorder

A condensed bulletin (51-553) dealing with the automatic CO_2 Recorder marketed by The Hays Corporation, Michigan City, Ind., explains the application of the instrument and a description of the principle of operation, complete with a detailed, two cover, schematic drawing. Such features as temperature compensation and self leveling are discussed; installation and sampling are described.

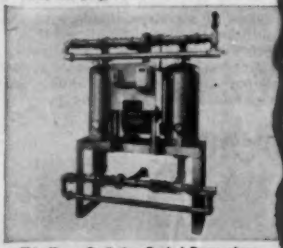
54. Gas Conditioning

Gas conditioning and Blaw-Knox gas equipment are the subjects of a bulletin published by the gas equipment department of Blaw-Knox Division of Blaw-Knox Company, Pittsburgh 19. Research bulletin No. 2353 contains photomicrographs showing the effects of en-

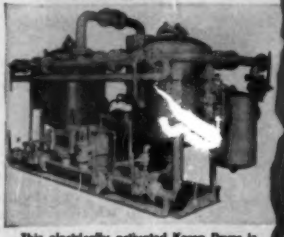


This Kemp Oriad Dryer is controlled by program timer. All operations, including blower reversals, fully automatic. Rated: 100 scfm, 100 psig, 70°F.

This Semi-automatic Kemp Oriad Dryer dries air for actuating tools, valves, etc.—dries process air and gases. Rated: 600 scfm, 100 psig, 70°F.



This Kemp Radiation-Cooled Dryer gives maximum efficiency with minimum maintenance and operating costs. Heating period terminates automatically. Rated: 300 scfm, 100 psig, 70°F.



This electrically activated Kemp Dryer is designed so gas stream is not contaminated by air normally used for reactivation. Rated: 3300 scfm, 100 psig, 70°F.

Cuts Costs on Moisture Control!

Kemp Dynamic Dryers dry Air, CO_2, Ammonia, Gasoline, Nitrogen, Propane to low dew points for as little as ½¢ per mcf

If you think drying air, gases or liquids costs too much—find out how Kemp can save you money! Hundreds of Kemp Dynamic Dryers *control moisture at low cost* in plants all over the country. Operation is guaranteed to your specifications and the cost is surprisingly low. Many Kemp users report drying to *sub-zero* dew points for as little as ½¢ *per mcf*—including all charges for labor, capital investment and materials!

Flexible Design

Kemp Dynamic Dryers are versatile—*offer manual, semi-automatic or automatic* operation. Desiccant is especially selected and compounded for the type drying your problem calls for. With Kemp you can dry *air, gases, or liquids, control humidity* in large or small areas, or *eliminate moisture* in materials. Gas, electric or steam regeneration is supplied as standard equipment.

Send for Information

Whether your moisture control problem is standard or special, you'll find Kemp has a Dynamic Dryer especially designed to solve it. Find out how Kemp engineering can be put to work for you to solve your problem . . . save you money. Write today and tell us your requirements. There's no obligation.

KEMP OF BALTIMORE

DYNAMIC DRYERS

WRITE FOR Bulletin D-27 for technical information,
C. M. KEMP MFG. COMPANY,
405 E. Oliver St., Baltimore 2, Maryland.

PROTECTION
All pipes insulated with molded insulation—protected with asphalt-covered heavy corrugated ingot iron conduit
ENGINEERING
Sectional insulation of any specification applied to individual pipes—protected with asphalt-covered iron conduit
INSULATING KNOW-HOW
Pipes nested inside laminated asbestos insulating liner—pipes are insulated from exterior but not from each other
make
Ric-wiL
the
ONE BEST
IN PREFABRICATED
INSULATED
PIPING

Ric-wiL PREFABRICATED INSULATED PIPING — UNDERGROUND OR OVERHEAD

THE RIC-WIL COMPANY · CLEVELAND, O.

New Equipment

(For additional information or literature check item numbers on mailing coupon, page 207, or write manufacturer direct.)

trained wet and dry dusts, a review of a new method for determining the entrained dust and oil content of gas streams—a "yardstick" developed by the Blaw-Knox research department, as well as photos of the testing apparatus. The section describing gas cleaners contains graphic aids on how to determine size to be used. Bulletin.

55. Phoscote Process

Information on the pickling and painting of steel plates, angles, channels and other shapes produced by rolling are discussed in a booklet, "The Phoscote Process," published by Chicago Bridge and Iron Company, Chicago 4. The company says the Phoscote process removes mill scale from steel plates and shapes by immersing the material in baths of sulfuric acid, wash water and phosphoric acid. The process provides a clean, dry surface with a coating of iron phosphate that improves the bond between the prime coat of paint and the steel. Booklet.

56. Corrosion Data

"Corrosion Notebook" published by The Carpenter Steel Company, Alloy Tube Division, Union, N. J., contains data on the corrosion resistance of various types of stainless tubing and pipe. In addition to providing data on types of corrodent at various concentrations, the notebook describes general types of corrosion, such as intergranular, galvanic, atmospheric and pitt-type.

57. Leak Detector

George W. Gates & Company, Inc., of Hempstead Turnpike and Lucille Avenue, Franklin Square, Long Island, has developed a lamp which generates a long wavelength ultraviolet ray. Natural and synthetic materials fluoresce under the influence of rays from carbon arcs and mercury lamps to disclose leaks of liquids in vessels of all kinds. The new lamp, known as the Raymaster Model TFS4-B90 black light exploring lamp, can be operated on a battery to prevent power circuit shock in wet conditions. The simple method of operation is to add a dilute fluorescing agent into the container being tested, and then in the darkness, to throw the black light on the vessel surface to watch for the telltale fluorescent liquid seeping through.

More Accurate Level Reading of LOW TEMPERATURE LIQUIDS . . .

JERGUSON

Large Chamber

NON-FROSTING* GAGES

YOU get the highest possible accuracy of reading on low temperature, low boiling point liquids with the patented Jerguson Non-Frosting Gage in the New Large Chamber model . . . because it insures less turbulence at the meniscus, and clear vision at the vision slot.

This new Jerguson model has 6 times larger area at the meniscus than the standard gage, so that there is a marked reduction in turbulence with light gaseous fluids that tend to boil or surge. Moreover, the problem of frosting encountered with these liquids has been eliminated by a patented frost preventing unit extending from the gage glass. This special transparent unit projects beyond the cover bolts and prevents frost from building up over the vision slot.

Here's a dual feature gage that assures greatly increased accuracy of reading for the process industries. If you have a problem with light gaseous fluids, or with gage frosting, it will pay you to investigate the new Jerguson Large Chamber Non-Frosting Gage . . . reflex or transparent.

Jerguson Large Chamber Gage, Transparent Type, with the patented Non-Frosting Gage Glass Extension. Write for literature on this gage, and on other non-frosting Jerguson models.

*Patented

JERGUSON

Gages and Valves for the Observation of Liquids and Levels

JERGUSON GAGE & VALVE COMPANY

100 Foilsway, Somerville 45, Mass.

Representatives in Major Cities

Please Listed Under JERGUSON

Jerguson Trees Gage & Valve Co. Ltd., London, Eng.

OIL AND GAS BURNING EQUIPMENT FOR EVERY INDUSTRIAL APPLICATION

Whether you burn pitch, tar, oil, gas or a combination of these fuels, there's a NATIONAL AIROIL BURNER for your job.

Our more than 38 years' experience in the design, development and manufacture of all types of industrial burners is at your service.

Ask us about your requirements . . . we'll gladly give you full information.

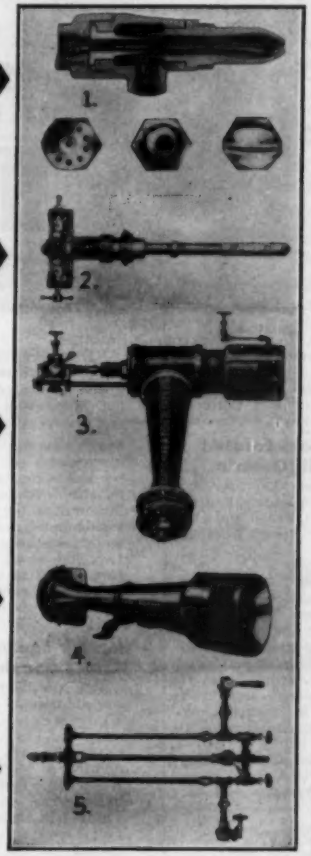
1. TYPE "SA"
(For use where steam is available) *atomizes thoroughly and burns completely*, the lowest and cheapest grades of fuel oil and tar, requiring only low oil pressure and temperatures.
Send for Bulletin No. 21.

2. TYPE "S-A-L"
(Large capacity burner similar to TYPE "S-A-R") is adaptable in combination with powdered coal burners in large boilers.
Send for Bulletin No. 24.

3. COMBINATION GAS AND OIL BURNER
—the "AIROCOOL" Gas Burner in combination with a TYPE "S-A-R" Oil Burner.
Send for "AIROCOOL" Brochure.

4. "AIROCOOL" GAS BURNER
(Of venturi type), assures low turndown without burnback.
Send for "AIROCOOL" Brochure.

5. TYPE "S-A-D"
(Refuse Oil Burner) burns acids or caustic oils, sludges, asphalts, tank bottoms, polymer oils, heavy petrolatum, organic oil residuums, waste cutting oils, sulphite pulp liquors, etc., in combination with fuel oil.
Send for Bulletin No. 21.



PRODUCTS

OIL BURNERS and GAS BURNERS for industrial power, process and heating purposes; STEAM ATOMIZING OIL BURNERS; MOTOR-DRIVEN ROTARY OIL BURNERS; MECHANICAL PRESSURE ATOMIZING OIL BURNERS; LOW AIR PRESSURE OIL BURNERS; GAS BURNERS; COMBINATION GAS and OIL BURNERS; AUTOMATIC OIL BURNERS, for small process furnaces and heating plants; FUEL OIL HEATERS; FUEL OIL PUMPING and HEATING UNITS; FURNACE RELIEF DOORS; AIR INTAKE DOORS; OBSERVATION PORTS; SPECIAL REFRACTORY SHAPES.

NATIONAL AIROIL BURNER CO., INC.

Main Office & Factory: 1234 EAST SEDGLEY AVENUE
PHILADELPHIA 34, PA.
SOUTHWESTERN DIVISION: 2512 SOUTH BOULEVARD
HOUSTON 6, TEXAS

SPEED TUBE MAINTENANCE

. . . with the WILSON·DUDGEON Model 50 Refinery Expander

YOU CAN BE SURE of fast easy rolling and solid seating of furnace, still and other heavy wall tubes with the specially designed self-feeding and parallel rolling Wilson-Dudgeon Refinery Expander. These expanders are available in multi-roll types, with and without flare rolls, thrust collars and "ironing-out" attachments. There is a Wilson-Dudgeon Expander available for any type of refinery fitting.

Model 50 Refinery Expander

. . . with the WILSON EP Series Air Motor and Model R Cutter Head.

Wilson EP Series Air Motor with Model R Cutter Head

YOU CAN PUT refinery equipment back "on the line" faster with the Wilson EP Series Air Motor and Model R Cutter Head. Size-for-size, the Wilson "EP" can develop up to 40% more power than ordinary motors. This extra power permits faster cutting action to remove hard heavy deposits in a hurry . . . even from tubes with large diameters. The "R" Cutter Head has renewable cutter pin bearings . . . works at faster cutting speeds . . . is self-feeding and non-tracking.

WRITE TODAY—or see your Wilson representative—for complete information on this time-saving, economical tube maintenance equipment. Ask for Bulletin 380 on Tube Expanders, 47A on Tube Cleaners.

THOMAS C. WILSON, INC.
21-11 44th AVENUE, LONG ISLAND CITY 1, N. Y.
CABLE: TUBECLEAN, New York

TW-780 **WILSON**

WILSON TUBE CLEANERS
WILSON-DUDGEON TUBE EXPANDERS AND SPECIALTIES

Specify
TYGON
PAINT
FOR PROTECTION AGAINST FUMES, CONDENSATES AND SPILLAGE

- Resists acids, alkalies, water, oil, gasoline, alcohols
- High dielectric strength—non-flammable
- Cold applied to wood, metal or concrete
- Applied by spray gun, brush, or dip
- May be air-dried or baked
- Glossy, easily cleaned surface

TYGON Plastic Paint coatings are a liquid formulation of Tygon sheet stocks, the chemically inert plastic used to protect acid tanks and equipment. Tygon Paints will not oxidize and chemically deteriorate with age. Resist most acids, alkalies, as well as oil, gasoline, fresh or salt water and alcohols. Will not contaminate solutions.

Free Test Sample

Please send free test sample of Tygon Paint, and copy of your new Paint Bulletin 720.

Name_____

Company_____

Address_____

1284-1

PROCESS EQUIPMENT DIVISION

U. S. STONEWARE

Since 1865 • Akron, Ohio

About EQUIPMENT and SERVICE Suppliers

Dowell's Tulsa Offices Completed With Oxyment

Dowell Incorporated, a wholly-owned subsidiary of The Dow Chemical Company has constructed a new modern office building at 1150 North Utica Avenue, Tulsa. Dowell's Truck, Magnesium Anode and Chemical Manufacturing plants, the warehouse and engineering research laboratories are located at the same address. The company used its new cement, Oxy-cement, a basic oxychloride cement, in the first commercial use of the material to finish the exterior and floors of the building. A premix, it can be used for flooring, boat decking, railroad car floors, pottery and novelties.

Purchasing, accounting, auditing, engineering and maintenance departments, formerly located in the Kennedy building, are housed in the new building.

Chiksan Appointees Located In Chicago, Brazil, Ontario

Appointments of two Chicago division heads as well as two foreign firms to represent the firm in Brazil and Ontario have been made by Chiksan Company of Brea, Calif.

N. A. (Lee) Guill, a Chiksan sales representative in the Chicago area for many years, was named division manager of the Chicago branch office as well as sales supervisor of the Chicago district. He will be assisted by W. L. Clark who terminated his services with Clark Company to become sales representative in the Chicago area.

G. W. Beecroft & Company, of Toronto, long time representative of American manufacturers in the Ontario area, have been appointed Chiksan distributors for their district.

In Brazil, the company will be represented by the Sociedade Commercial de Materias Primas Ltda., of Rio de Janeiro. With branches in most large cities in Brazil, they have been popular distributors for many American manufacturers of oil field equipment. The Petroleum Department is headed by Dr. Edgard Frias Rocha who was engineer for the National Petroleum Council from 1939 to 1942.

Tenamene Trademark Created by Tenn-Eastman for Direct Sales

"Tenamene" will be the tradename of gasoline additives manufactured by Tennessee Eastman as the company takes over the direct sale of its products. Until now the company's entire production of gasoline additives was marketed through a second company. A pioneer in the field of antioxidants, Tennessee Eastman began manufacture of gum inhibitors for gasoline over fifteen years ago with certain wood oils which were by-products of wood distillation operations. Not long afterward company technicians developed a method of producing one of the first synthetic gasoline antioxidants, N-butyl-p-aminophenol, now to be known as Tenamene 1. Tenamene 1, 2, and 60 will be sold by existing organizations in major U. S. cities. The company is a division of Eastman Kodak Company.

Mixing Equipment Appoints James Donohoe New Sales VP

James V. Donohoe was appointed vice president in charge of sales of Mixing Equipment Company, Inc., of Rochester, N. Y., last month. A native of Rochester, Donohoe has served Mixing Equipment Company for 17 years. He joined the company as purchasing agent, following which he was successively office manager, assistant sales manager, and sales manager. Mixing Equipment Company manufactures an extensive line of fluid mixers and agitators for the process industries which are sold under the trade-name of Lightnin mixers.

Donohoe

York's Pacific Coast Sales Awarded to Jacobs Engineering

Pacific Coast sales and engineering for Otto H. York Company, Inc., will be handled by the Jacobs Engineering Company, 417 South Hill Street, Los

Angeles, under the direction of Joseph J. Jacobs and Harry Vinoch. The York line includes wire mesh entrainment separators and mist extractors, multi-stage liquid-liquid extraction equipment, wire barriers, etc., used in petroleum and allied industries.

Wilson to Cover Ft. Worth-Waco Area for Eggelhof Engineers

James A. Wilson, new assistant manager of the Dallas division, will represent Eggelhof Engineers, manufacturers of industrial controls and equipment, throughout the Fort Worth - Waco area. Dallas and North Texas continue to be covered by Jack Rush.

Wilson

Wilson, a graduate of the University of Oklahoma in mechanical engineering, spent four years as a process and development engineer with several equipment manufacturers, including work on the Manhattan District Project. Since 1945 he has been a field engineer with Elliott Company in Tulsa and Dallas.

Walther Heads Expanded Dowell Cathodic Protection Sales

Promotion of Herb Walther, Jr., Tulsa representative of the Industrial Division of Dowell Incorporated in Virginia, to head of the Cathodic Protection department coincided with the expansion of the department's Chicago and New York branches.

William E. Bunting, a staff member since 1944, has been named development engineer in Chicago. A registered professional engineer, he is a graduate of Wheaton College in Illinois.

Richard W. Stetson was named Dowell cathodic protection representative in New York City. He is a graduate of Tri-State College, Indiana. Stetson has been a Dowell employe since 1948.

Walther attended New York University and Brooklyn Polytechnic Institute, has been with Dowell since 1944.

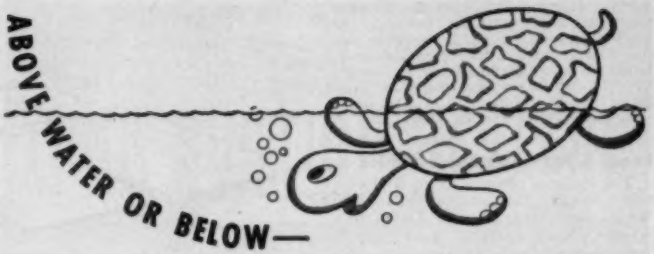
Edwin Price Named West Coast District Manager by M, M, & M

Edwin H. Price succeeds Newton P. Selover as Pacific Coast district manager of Manning, Maxwell & Moore, Inc., Bridgeport, Conn. Selover becomes director of export planning.

Price, a graduate of the U. S. Naval Academy and Columbia University (M. S. degree in engineering) joined the company in 1930. During the last war, he served in San Francisco as assistant supervisor of shipbuilding for the Navy. His headquarters will be in Los Angeles.

Baldwin-Hill Company Buys Temple, Texas, Insulation Plant

Tex-Rock Insulation Manufacturing Company of Temple, Texas, was purchased by the Baldwin-Hill Company of Trenton, N. J., last month. Baldwin-Hill has manufacturing divisions located at Trenton, N. J., Kalamazoo, Mich., and Huntington, Ind. W. H. Hill, presi-



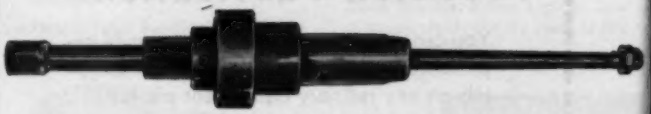
HYSOL 4000 COATINGS Stop Corrosion!

Wherever salt water, chemicals or fresh water cause corrosion . . . gain up to 10 years' protection with Hysol Coatings. Applied by brush, spray or roller, these tough, abrasion-resistant coatings are available in eight rich colors. Quick drying in air, they are equally adaptable for use above or below the water line. Write for technical data.

★ Have given two years of salt water service on one ship bottom.
★ Outstanding resistance to abrasion.
★ Sure adhesion to all metal surfaces.

houghton laboratories, inc. OLEAN, NEW YORK
PLANTS AT OLEAN, N. Y. AND SMETHPORT, PA.

The Newest Expander
TYPE "FC"
WITH FRICTIONLESS COLLAR



BY THE OLDEST
ORIGINAL MANUFACTURER
OF TUBE EXPANDERS

A general purpose tube expander for condensers and heat exchangers. Ideal for automatic control units. Ball bearing thrust collar eliminates marring and friction on tube ends produced by thrust of expander.

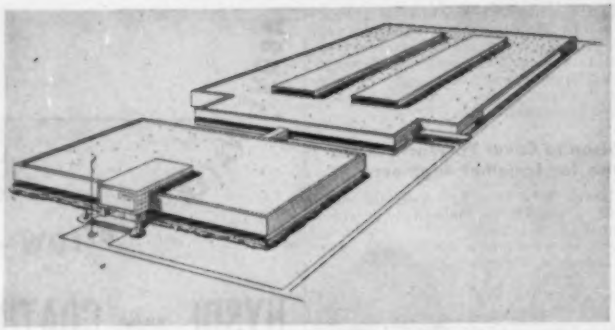
RECESSED COLLARS FOR PROJECTING TUBES
CAN BE FURNISHED WHEN SPECIFIED

A. L. HENDERER'S SONS
620 MARYLAND AVENUE
WILMINGTON, DELAWARE
Write for Bulletin 80-130

dent of Baldwin-Hill, said the Temple plant was added to the company in order to supply the rapidly growing demand for industrial and domestic insulation materials in the southwest. George W. Elliott, former president of Tex-Rock, has been appointed to sales management for the Temple plant.

Leeds & Northrup Moves Office

The Houston office of Leeds & Northrup Company has been moved to 2480 Times Boulevard, Houston 5. The new office doubles available space and affords better facilities for supplying engineering information and service to manufacturers, researchers, and educational institutions in the area from New Orleans to the California line.



CRANE PACKING COMPANY of Chicago is building new general offices and plant facilities on Oakton Avenue near Lehigh in Morton Grove, Ill., which will cover 133,000 square feet. Manufacturers of industrial packings, mechanical seals, oil seals and, more recently, the new "John Crane" Lapmaster, a precision lapping machine, the company in the past 40 years has become one of the largest manufacturers in its field. Architects and engineers are Olsen and Urbain of Chicago.

General Controls Adds Five District Offices

Five new factory branches, bringing the total branches to 29, have been opened by General Controls Company of Glendale, Calif., manufacturers of automatic controls. Managers for three of the offices have been announced as: John Ferguson, Salt Lake City; Albert Smith, Milwaukee; and Elton Barnett, Omaha. Offices will be opened in El Paso and New Orleans also.

New supervisory district procedure will place several factory branch offices under guidance of a district manager. The six district divisions and their managers are: F. J. Wengerter, New York and Newark; Fred Angier, Philadelphia and Baltimore; Charles Tabor, Cleveland, Columbus and Buffalo; Bud Lerch, Chicago area; Herbert Lindstrom, Denver area; A. E. Bud Hess, Houston and New Orleans; the Eastern section will continue under the supervision of Fred Weldon, Chicago.

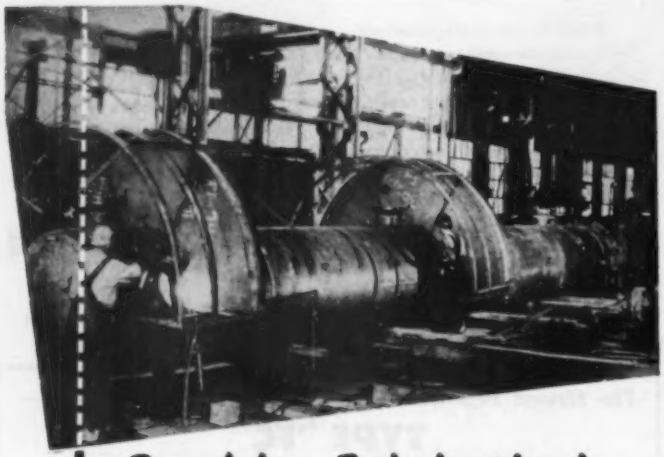
NACE Conference-Exhibition Officials Announced for 1952

Officials for the 1952 Conference and Exhibition of the National Association of Corrosion Engineers have been named as follows: Walter F. Rogers, Gulf Oil Corporation, Houston, general chairman; Robert L. Bullock, Interstate Oil Pipe Line Company, Tulsa, technical program chairman; Jack W. Harris, Cameron Iron Works, Houston, exhibition chairman, and Charles G. Gribble, Jr., Metal Goods Corporation, Houston, local arrangements chairman.

The conference will be held at Galveston, Texas, in March. It will be the first time since the 1944 meeting at Houston that the association has held a national meeting in the Southwest. A four-day technical program and exhibition will be featured.

Wheelco Agency in Charleston

Engineering Products Company, P. O. Box 1107, Charleston 24, W. Va., has been made a new district agency of The



Precision Fabrication!

You can depend on McNamar's years of experience to give you the best fabrication job on any refinery equipment project . . . We take a great deal of pride in tackling the tough problems too!

McNAMAR PRODUCTS—REFINERY TOWERS • STORAGE TANKS • ACCUMULATORS—SEPARATORS • HEAT EXCHANGERS • PIPING—STRUCTURAL SHAPES • MISCELLANEOUS REFINERY VESSELS.

McNAMAR FACILITIES—70-TON CRANE • ROLLS 1¼" PLATE THICKNESS • X-RAY EQUIPMENT • NATIONAL BOARD INSPECTION • AUTOMATIC WELDING • API-ASME CODE WELDING • STRESS RELIEVING SAND BLASTING.

McNamar Boiler & Tank Co.

REFINERY SALES DIVISION • BOX 868, TULSA, OKLAHOMA

Wheelco Instruments Company for West Virginia. The new office will be under the direction of F. E. Anderson, and will handle sales and service facilities for Wheelco Recorders, Controllers, and Combustion Safeguards.

Alcoa Transfers Koepke To Kansas City Sales

Boyd F. Koepke, who has been located in the Dallas district sales office of the Aluminum Company of America since 1946, has been transferred to Kansas City. Koepke is identified with the Chemical Products division of the company and will continue doing sales development work in that department. His work involves sales concerning the dehydration of LPG and natural gas with Alcoa activated alumina and the utilization of Alcoa's aluminas for fluid catalytic work, aluminum heat exchanger tubes for condensers and exchangers in refineries and gasoline plants, as well as aluminum tubing for instrument air lines from process to instrument panel. He will cover Oklahoma, Kansas, Colorado, Nebraska, Utah, Wyoming and the Texas Panhandle representing the company in sales promotion, development, and education.

Koepke

Burgess-Manning Appoints Three to Dallas Branch Office

The staff of the newly created petroleum industry headquarters of the Burgess-Manning Company at 1203 Dragon Street, Dallas, was recently increased by three new appointments:

R. H. Campbell, formerly purchasing agent and traffic manager for the Dallas Tank Company, was named purchasing agent and traffic manager.

W. C. Jack, who also came from the Dallas Tank Company, has been appointed design engineer.

R. T. Oliver was appointed sales correspondent to assist in the facilitating of field operations.

General American Promotes Duffy to District Manager

General American Transportation has promoted Ben King Duffy, former sales engineer, to district sales manager of the Plate & Welding Division for the Pittsburgh district. His territory includes parts of Pennsylvania, Kentucky, Ohio, West Virginia and Tennessee. Duffy will direct sales for such General American products as are fabricated by the company's Plate & Welding Division as well as Wiggins Conservation Structures and Wiggins Gasholders.

Insul-Mastic Names Bulmer

New manager of Insul-Mastic Corporation of America's newly formed west coast branch is George A. Bulmer, who will headquarter in Los Angeles. Insul-Mastic manufactures protective coatings for prevention of corrosion in industry, and waterproof ceilings for commercial buildings and homes, as well

HAVING TROUBLE PUMPING HEAVY OILS?
CONCERNED ABOUT LOSSES RESULTING FROM VOLUME SHRINKAGE AT LOW OIL DELIVERY TEMPERATURES? ...THEN INSTALL

Paracoil

TANK SUCTION HEATERS

TO SOLVE YOUR PROBLEMS

TANK SUCTION HEATER INSTALLATION

The shell is open at the inside end. The oil moves across the heating tubes as it passes through the shell to the suction connection outside the tank.

In Bulk Oil Terminals and Refineries the world over Paracoil Tank Suction Oil Heaters are licking the problem of economically preheating heavy viscous oils to permit their withdrawal from storage tanks. They are also preheating the lighter grades of fuel oils to their proper delivery temperatures to avoid the costly volume losses incurred when such oils are sold at low temperatures.

WITH PARACOIL TANK SUCTION OIL HEATERS

- You Heat Only The Oil That Is Being Withdrawn From The Tank. (Thus radiation losses resulting from heating entire tank contents are eliminated.)
- Overall Steam Consumption And Heating Costs Are Held To A Minimum.
- Heater Tube Bundle Can Be Withdrawn For Inspection And Cleaning. Breaking of oil suction line not necessary.
- All Piping Connections And Gaskets Are Outside The Tank.
- U-Tube Design Permits Free Expansion And Contraction Of Tube Bundle. Either high or low pressure steam can be used as the heating medium.

SPEED UP DELIVERIES AND CUT OIL VOLUME LOSSES WITH PARACOIL TANK SUCTION HEATERS

Prompt Shipments! Our extensive stocks of tubing and pipe enable us to make quick deliveries to meet your immediate requirements.

Write for Descriptive Literature

In addition to the Paracoil Tank Suction Heaters, we also design and fabricate Line Type Discharge Heaters of any capacity. Illustrated is a Paracoil Straight Tube Type Fuel Oil Heater for bulk station service—capacity 2,000 gallons per minute, No. 6 oil, 100°F to 160°F, steam at 15 psig. Weight 12 tons.

DAVIS ENGINEERING CORPORATION

1060 East Grand Street, ELIZABETH 4, NEW JERSEY
30 Rockefeller Plaza, NEW YORK 20, N. Y.

as insulation for tanks, pipes and metal panels which are subject to condensation. Bulmer was formerly associated with Marine Engineering and Supply Company, an Insul-Mastic licensee, and is a trained civil engineer.

Shriver Names New Officers

William L. Hutton was named president of T. Shriver & Company, Inc., of Harrison, N. J., to succeed John L. Hutton who died May 12. Named at the same time were J. Laurence Hutton, vice president and treasurer; John H. Clark, Jr., vice president and sales manager; and Herbert H. Flagg, secretary.

John Hutton, a graduate of Princeton University, had been associated with the company for 33 years and had acted as president and general manager since 1939.

Kirk Mattson Joins Pennsalt As Los Angeles Sales Manager

Kirk C. Mattson of San Marino, Calif., recently joined the Pennsylvania Salt Manufacturing Company of Washington as district manager of the company's Los Angeles office. He will supervise sales and service of the industrial chemicals and agricultural chemicals departments in Southern California, Arizona, Nevada and New Mexico. Until recently, Mattson operated his own chemical sales agency in Los Angeles.

Testing Laboratories Enlarged

The Los Angeles laboratories of United States Testing Company, Hoboken, N. J., recently moved into larger quarters on 1723 South Maple Avenue, Los Angeles. Frank Brennen is Los Angeles branch manager. The new laboratory site is equipped to handle chemical, paint, engineering and engineering-inspection tests. Much of the work formerly referred to the Hoboken laboratories can now be done in Los Angeles.

Rowand Becomes General Mgr. Rockwell's Pittsburgh Plant

Norman W. Rowand has been appointed general manager of the Pittsburgh plant of the Rockwell Manufacturing Company's Meter and Valve Division.

Rowand

Rowand was chief industrial engineer for the Pittsburgh-DuBois Division, Du Bois, Pa., as well as plant manager of the Regulator Division at Norwalk, Ohio.

Before joining the Rockwell organization he was employed by the J. R. Wald Company, Huntington, Pa., as general superintendent and with the Screwwercs Company, Sykesville, Pa., as plant manager.

Evans to Manage Rochester Branch for Worthington Pump

Manager of the newly opened Rochester, N. Y., branch office of Worthington Pump and Machinery Corporation is L. M. Evans. The office is located at 1246 Sibley Tower Building. Evans, who holds a B.S. degree in electrical engineering from Cooper Union Institute of Technology in New York, has been employed by the company since 1936. The new manager has a varied background that includes five years residence in the British Colony of Sierra Leone, West Africa, and engine room runs on many Panama Steamship Lines ships, a job he held during college vacation months. He is a member of the AIEE, ASME, National Society of Professional Engineers, and the University Club of Syracuse.

Magnesia Insulators Retain Kieselbach as Tech Consultant

Retired as general manager of the Insulation Department for Johns-Manville Sales Corporation, Harry A. Kieselbach has been retained as technical consultant to the Magnesia Insulation Manufacturers Association. He has served as chairman of the association's technical committee since it was formed in 1945. He will make his headquarters in his home at Montclair, N. J., although the association's office is in Washington.

Taylor Instruments Move

Taylor Instrument Companies have moved to larger offices located at 5001 Navigation Boulevard, Houston.

PIE Opens New Rochester Office

Process Industries Engineers, Inc., of Pittsburgh, has opened an office at 703 Temple Building, Rochester, N. Y., under the management of Larry Woll, recently appointed western New York district manager. Woll, who has been a member of the Pittsburgh sales office, will represent the Engineering and Construction division which handles manu-

NATURAL GASOLINE PLANTS

- *Oil Refinery Equipment*
- *Structural Steel*
- *Steel Plate Fabrication*
- *Chemical Processing Equipment*

FLINT STEEL CORPORATION
TULSA, OKLAHOMA

facture of special process equipment and the designing, engineering and erection of process units, pilot plants and complete plants and systems.

Graver Promotes Harry Dennis To Assistant Sales Manager

Harry A. Dennis, appointed new assistant sales manager for Graver Tank & Manufacturing Company, Inc., is a metallurgy graduate of Penn State University and has been in Graver employ for more than two years. He is promoted from manager of sales of the Weldment division as well as the Alloy division. As assistant sales manager for the company he will assist Willard M. Broxham. Before joining Graver he worked for Lukens' Welding Research and Service Engineering, progressing from part time helper in the open hearth during his college days, to assistant district manager of sales.

Dennis

Los Angeles Facilities of American Cyanamid Centered

Construction of a one-story building that will contain 64,000 square feet was begun in Los Angeles by John M. Stahl and Buttress and McClelland, Inc., for lease to American Cyanamid Company. Air-conditioned offices have been allotted 20,000 square feet and the warehouse 44,000 feet in this building designed primarily to fill the chemical company's requirements. Additional land at the site affords an expansion potential should it be required.

At present American Cyanamid Company occupies many isolated offices and the new building will effect a consolidation of facilities.

Ericson Appointed Amarillo Chemist for Continental Carbon

Continental Carbon Company recently appointed Harry L. Ericson as chief chemist of its new laboratory,1440 West Tenth Avenue, Amarillo, Texas. Before moving to Amarillo, Ericson was employed in Witco Chemical Company's research laboratories in both New York and Chicago. He received his B.S. degree in chemical engineering from Northeastern University in Boston.

Sarco Midwest Office Moved

Midwest headquarters of the Sarco Company, Inc., were moved to 322 West Randolph Street, Chicago. Main sales offices for the company are located in the Empire State Building, New York, while the factory is located at Bethlehem, Pa. George H. B. Burke, manager of the Midwest headquarters, has been with Sarco 40 years. Other veteran sales engineers include R. L. Stewart, C. E. Brakenridge, E. J. Avery, O. W. Clark, D. E. Shrader, and C. F. Bremigan.

GE Promotes Dr. Rader

Dr. Louis T. Rader has been appointed assistant manager of engineering of the General Electric Company's Control division at Schenectady, N. Y. Dr.

You get SUPERSONIC ACTION with a BLAW-KNOX FOG SYSTEM

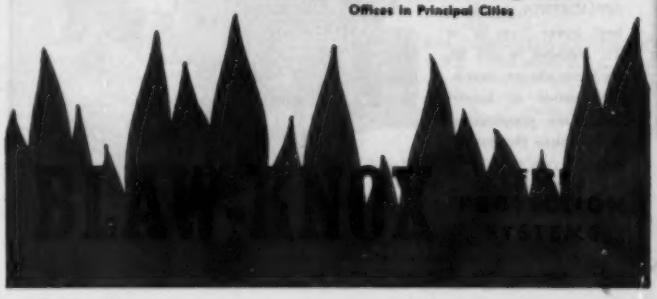
Deluge Systems, Wet Pipe Systems, Dry Pipe Systems, Water Spray and Fog Systems, Rate-of-Rise Sprinkler Systems, and Foam and Carbon Dioxide Extinguisher Systems.

"LITTLE JOEY SPRINKLER"

At the very first appearance of fire (inside or outside your plant) the Blaw-Knox rate-of-rise thermostat instantly sounds an alarm and, with the speed of electricity, starts a dense, quenching fog of water at the danger spot—smothering the fire and protecting adjacent equipment. Blaw-Knox Fog Nozzles have no screens to clog, do not require treated water and maintain their effective spray pattern even at reduced pressures.

At your request a Blaw-Knox Engineer will make a survey of your fire hazards, prepare a preliminary layout of the system that will give the utmost in fire protection, and submit an estimate of costs—without obligation. Blaw-Knox Fire Protection Systems carry the approval of all insurance underwriters.

BLAW-KNOX SPRINKLER DIVISION
OF BLAW-KNOX CONSTRUCTION COMPANY
829 Beaver Ave., N.S., Pittsburgh 33, Pa.
Offices in Principal Cities



IN WIRE-MESH PRODUCTS
LET JELLIFF DO IT!

For 70 years we've been weaving Wire Mesh. And a good part of that time we have also been making things of Wire Mesh for people who find it is cheaper, easier and generally more satisfactory to "let Jelliff do it." From big Dipping Baskets to tiny precision filters—from fuel strainers to what-is-it gadgets—JELLIFF's Custom Production Department turns out fabricated Wire-Mesh products at speed, price and precision that mean lower costs and a stronger competitive position for our many customers.

If you buy or make wire-mesh assemblies as components of your own products and have not yet had an estimate from Jelliff, write today for details. No obligation, even if you enclose a blueprint for us to figure on. Address Department 16.

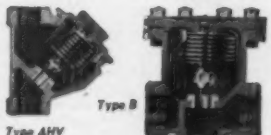
THE C. O. JELLIFF MFG. CORP.
DIPPING BASKETS · LEKTROMESH · RESISTANCE WIRE
WIRE MESH PARTS · WIRE CLOTH · STRAINERS · FILTERS
SOUTHPORT CONNECTICUT
WIRE PRODUCTS SINCE 1860

Large Processor Achieves

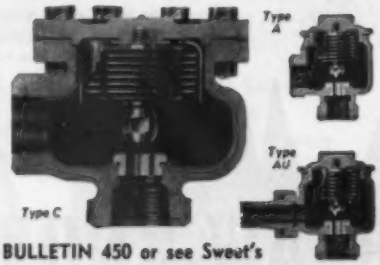
MORE UNIFORM HEATING CYCLES

With Nicholson Steam Traps

The positive action of Nicholson traps was recently used successfully by a chemical maker to smooth out the heating cycles of cookers at 50 to 60 minutes, against previous periods up to 105 minutes. Steam flow was upped to 3000 lbs. an hour against 2000 for the previous mechanical type.



5 TYPES FOR EVERY APPLICATION, process, heat, power. Sizes ¼" to 2"; pressures to 225 lbs. To learn why an increasing number of leading plants are standardizing on Nicholson thermostatic traps . . .



Send for BULLETIN 450 or see Sweet's

W. H. NICHOLSON & CO., 207 Oregon St., Wilkes-Barre, Pa.

Rader who holds a B.S. an M.S. and Ph.D. in electrical engineering from the California Institute of Technology, has been employed by General Electric Company since 1937 except 1945 to 1947 when he was head of the Electrical Engineering department at the Illionis Institute of Technology.

Thermometer Firm Promotes David McEwen Sales Manager

Rochester Manufacturing Company appointed David McEwen sales manager of the company and Ralph Foster to assist in the sale of industrial thermometers in the refining and processing industries. John W. Kershaw will assist in oil burner industrial sales.

McEwen

McEwen joined the company in 1936 and has had ten years of production experience in thermometers, pressure, liquid level, and temperature gauges. In his new capacity he will handle the sales of liquid level, pressure and temperature gauges as well as special government sales.

Edward Roper Promoted by Air Reduction Sales Company

Air Reduction Sales Company recently appointed Edward H. Roper manager of the general technical sales department. Roper, who joined Air Reduction in 1936, served in various capacities in the department and was appointed assistant to the manager in 1944. During the war he instructed aircraft welding classes at the University of New York. Roper received his B.S. in mechanical engineering from the Sheffield Scientific School, Yale University. A licensed engineer in New York, he has presented technical papers before various societies, and is co-author of "Oxygen Cutting," a recent text book.

Roots-Connersville Erects $1.5 Million Building

Construction costing $1.5 million was undertaken recently by Roots-Connersville Blower Corporation in a program covering new erection floor, expansion of present facilities, manufacturing space, and machine tools. These new facilities will enable the company to test the largest centrifugal blowers and compressors ever designed, and now under construction. The company recently completed a contract covering a ten-unit order of centrifugal compressors requiring 53,000 hp.

Darling Will Manufacture United Pumps in Canada

An agreement concluded between Darling Brothers, Ltd., of Montreal, and United Centrifugal Pumps, a division of the United Iron Works, Oakland, Calif., provides for the manufacture of United's complete line of pumps in Canada.

United specializes in the manufacture of pumps for the petroleum and chemical industry as well as for petroleum pipe lines and central power stations and has made installations in far-flung sections of the globe. Darling Brothers

ESPECIALLY RECOMMENDED FOR USE IN THE
Copper Sweetening Process

NICHOLS
TRIANGLE BRAND

COPPER SULPHATE

is preferred by leading refineries because of its high copper content, dependable uniformity and exceptional purity and freedom from foreign and inert matter.

99%+ PURE

Quotations on request, on any quantity required. Shipments can be made from our nearest plant.

PHELPS DODGE REFINING CORP.
40 Wall Street, New York 5, N. Y.
230 North Michigan Avenue, Chicago 1, Ill.

Is your cooling tower meeting design specifications . . . giving trouble-free operation?

Is it . . . free of accumulative algae . . . safe from structural failure . . . subject to accelerated deterioration?

Does it have . . . full decking in good repair . . . minimum drift loss efficiency?

Use these 2 Fluor Services

1. Let Fluor inaugurate a preventative maintenance program—free of charge.
2. Let Fluor inspect for needed repair—recommend on a competitive bid basis.

Inquire through any Fluor Office
THE FLUOR CORPORATION, LTD.
2500 SOUTH ATLANTIC BLVD., LOS ANGELES 22, CALIF.
offices in
NEW YORK • CHICAGO • TULSA • HOUSTON • SAN FRANCISCO

recently manufactured several large units for the Canadian Oil Companies' new plant at Montreal East, and are presently producing United process pumps for a Sarnia, Ontario, refinery.

New Ethyl Official Heads Unification Department

Turner

Unification of research, engineering, product development and new construction for Ethyl Corporation will be directed by H. Bynum Turner who was recently elected a vice president of the corporation. Promoted from general manager of the manufacturing department, Turner will be succeeded in that capacity by Clinton W. Bond. Roy N. Clothier has been named plant manager to fill Bond's post at Baton Rouge. The Ethyl plant now under construction at Houston, Texas, will be managed by Wallace F. Armstrong.

Turner, a Rice Institute graduate, was employed by Humble Oil & Refining Company at Baytown, Texas, for eleven years before joining Ethyl in 1939 as a supervisor.

Safety Leader Humphreys Named ACF Property Manager

Forest H. Humphreys, who has been active in country-wide safety movements for many years, was appointed manager of the property department of the American Car and Foundry Company this month. Humphreys, who succeeds John H. Green, had been assistant manager of the department since 1950 when the safety and claims division of which he was head, merged with the property department. He entered ACF employ in 1916 as a riveter and subsequently worked his way through various jobs to his present position.

Among his safety activities, Humphreys fostered the organization of workers whose sight had been saved in accidents by safety glasses into ACF Wise Owl Clubs and also sponsored the formation of elementary school safety clubs at Jeffersonville, Ind.

Dr. Fleming Heads Girdler Catalyst Development Program

Dr. H. W. Fleming joined the Research and Development Department of The Girdler Corporation of Louisville,

EXCEL-SO
COALESCERS
remove all free water from products streams prior to dessicant dehydration.
Send For Descriptive Bulletin
WARNER LEWIS COMPANY
P. O. BOX 3096-D • TULSA, OKLA

let THIS Remind YOU!

That WEATHERCOAT—

- **TROWELS EASILY**
- **STAYS FLEXIBLE & TOUGH**
- **STAYS SEALED**

Laykold

WEATHERCOAT PROTECTS

the insulation on your hot or cold vessels — for YEARS!

Specified by Leading Refineries for over 15 Years.

Also Try —

MASTIC WEATHERCOAT —
New and ready-mixed for void-filling scratch coat.

Ask for specifications and data.

In the East
AMERICAN BITUMULS COMPANY
200 BUSH STREET • SAN FRANCISCO 4, CALIF.
Washington 6, D. C. • Baltimore 3, Md. • Perth Amboy, N. J. • Columbus 15, O. • St. Louis 17, Mo. Baton Rouge 2, La. • E. Providence 14, R. I. San Juan 23, Puerto Rico • Mobile, Ala.

In the West
STANCAL ASPHALT & BITUMULS COMPANY
200 BUSH STREET • SAN FRANCISCO 4, CALIF.
Los Angeles, Calif. • Oakland 1, Calif. Portland 4, Ore. • Seattle, Wash. • Tucson, Ariz.

5 Quality Products for the Petroleum Industry

SOLVAY

TRADE-MARK REG. U. S. PAT. OFF.

SODA ASH

CAUSTIC SODA

CAUSTIC POTASH

(Liquid, Solid and Flake)

CALCIUM CHLORIDE

SODIUM NITRITE

For complete information, contact the nearest Solvay *office*

Soda Ash · Caustic Soda · Caustic Potash · Nytron · Calcium Chloride
Chlorine · Potassium Carbonate · Sodium Bicarbonate · Formaldehyde
Specialty Cleansers · Ammonium Bicarbonate · Sodium Nitrite
Para-dichlorobenzene · Ortho-dichlorobenzene · Monochlorobenzene
Ammonium Chloride · Methanol

SOLVAY
Alkalies Chemicals
70 YEARS OF SERVICE
1881 1951

SOLVAY SALES DIVISION
Allied Chemical & Dye Corporation
40 Rector Street, New York 6, N. Y.

BRANCH SALES OFFICES

Boston · Charlotte · Chicago · Cincinnati · Cleveland · Detroit
Houston · New Orleans · New York · Philadelphia · Pittsburgh
St. Louis · Syracuse

VICTOR alloy Studs and Bolts have met the exacting standards of the oil industry for more than 30 years. Victor is accustomed to meeting your requirements of quality, price and delivery. Try VICTOR next time you need any fastening.

Write for the new, easy to use VICTOR catalog.

VICTOR PRODUCTS CORP.
2635 W. BELMONT AVE. :: CHICAGO 18, ILL.

CALCULUS FOR PRACTICAL ENGINEERS

By DR. ALOIS CIBULKA
University of Texas, Austin, Texas

Calculus, a High Speed Tool for the Engineers.

Calculus, like the Slide Rule, is an important time saver and just like the Slide Rule, outside of its complicated appearance, there is not much to it. Anyone who studied college algebra and geometry can master practical Calculus in a short time.

Every engineer should have a working knowledge of Calculus.

There is hardly an engineering formula that did not require Calculus for its derivation.

The practical value is demonstrated by many actual engineering problems.

The integration and the differential equations will come easy to you. The whole Calculus is far more a patient juggling of the familiar algebraic formulas than a work of a genius mind. Its practical value is great in every branch of engineering. For example, in structural design: Reinforced concrete and welded steel structures are gaining ground more and more.

The rigid frames, the statically indeterminate structures are more economical and more adaptable to many different shapes. There may be other methods for their calculations, but why not use the Calculus, which you had to study anyway, for this purpose? The theory of such structures, with examples, is given in this book.

100 Pages: Size 12" x 9½"; Paper Bound. Price, $3.00

"Prices subject to change without notice"

Send Orders to the

GULF PUBLISHING COMPANY
P. O. BOX 2608 HOUSTON, TEXAS

PETROLEUM REFINER CLASSIFIED ADS

RATES for Classified Ads are $5 per column inch. Minimum size one column inch. In smallest type size, figure 50 words per inch. Situations Wanted $4 per column inch. All classified ads payable in advance. Ten percent discount if three or more insertions are ordered at same time. COPY DEADLINE is 25th of month preceding date of issue. Send copy and checks to: Classified Ad Department, Petroleum Refiner, P. O. Box 2608, Houston 1, Texas.

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

CAPITAL TO INVEST

Engineer will purchase all or part interest in substantial equipment or engineering company. Box 198-R, c/o Petroleum Refiner, Houston, Texas.

Chemist or Chemical Engineer

One of the leading chemical companies desires chemist or chemical engineer to do laboratory research on end uses for new products developed in existing research department. At least 3 years experience essential in one or more of the following products: waxes, paper coatings, polyethylenes and other plastics. Permanent position, good salary, liberal employment benefits. Give complete information in letter. Replies confidential. Box 197-R, Petroleum Refiner, Houston, Texas.

OPPORTUNITIES FOR

TECHNICAL REFINERY PERSONNEL

for

LARGE INTERNATIONAL OIL COMPANY

Entertaining applications of graduate chemical, mechanical, structural and electrical engineers for refinery engineering assignments at home and abroad.

Engineers with refinery experience and also recent graduates will be considered.

Box 196-R, Petroleum Refiner, Houston, Texas

Ky., to direct the company's expanding catalyst development program.

Dr. Fleming holds a B. A. degree from Kenyon College and a Ph.D degree from Western Reserve University, and is a member of A.C.S., Phi Beta Kappa and Sigma Xi. Before associating with The Girdler Corporation, Dr. Fleming was a group leader in the Phillips Petroleum Company's Research and Development Department.

GE Appoints Vinson to Head Relations for Small Apparatus

Arthur F. Vinson, who recently completed the Advanced Management Program at Harvard University's Graduate School of Business Administration, was recently appointed manager of employe and community relations of General Electric's Small Apparatus Divisions with headquarters at Lynn, Mass.

Vinson earned his B. S. degree in electrical engineering from Michigan State College and joined GE at Fort Wayne, Ind., in 1929 as a member of the Test Course staff. Until his promotion he was manager of the Welding Divisions at Fitchburg, Mass.

Airetool Enlarges Expander Line With Acquisition of Ajax

The Airetool Manufacturing Company of Springfield, Ohio, recently acquired Ajax Expander Company, Fairview, Pa., enabling Airetool to manufacture a more complete assortment of tube cleaners and expanders for industrial, chemical, refinery and marine needs. Ajax equipment has been moved to Springfield where Airetool will continue to supply Ajax "Collins Type," and "C.B.," "P.R." and Linsen series of tube expanders.

Link Joins Rockwell As Valve Engineer for South California

John B. Link, formerly a member of the Apparatus Sales Division of the Southwestern Engineering Corporation, has been appointed valve engineer for the southern California area by Rockwell Manufacturing Company. He will be responsible for the sale of valves used by oil refineries and engineering companies in the area.

Link, a petroleum and mechanical engineering graduate of Texas A. & M., was at one time the San Francisco sales representative for C. F. Braun and Company.

Donohue Gets Sales Promotion At GE's Trumbull Company

Douglas J. Donohue, who joined Trumbull Electric Company in 1930 as a member of the company's Pacific Northwest staff, was appointed Atlantic district sales manager for Trumbull, a department of General Electric Company, Plainville, Conn. Donohue will maintain his office in Philadelphia.

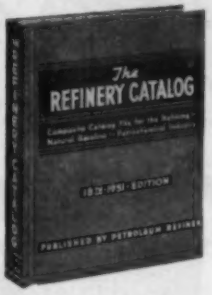
A registered professional engineer, Donohue attended the University of Washington and is a member of the Electrical Club of Washington and the Engineers' Club of Seattle. Appointed head of engineering for the Pacific Northwest in 1940, he has since 1945 been a salesman for the Eastern territory.

ADVERTISERS

in the July, 1951, issue of

Petroleum Refiner

The asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in The 1951 Refinery Catalog.



A

*Aerofin Corp. 38
Air Reduction Magnolia Co. Opp. 169
*Airetool Manufacturing Co. 190
Alan Wood Steel Co. 194
Allied Chemical & Dye Corp. 232
*Allis-Chalmers Manufacturing Co. 7
*Aluminum Company of America 11, 94
American Bitumuls Co. 231
*The American Brass Co. 163
*American Locomotive Co. 9
American Meter Co. 23
American Steel & Wire Co. 192
Armstrong Cork Co. 55
*Armstrong Machine Works 5
*Attapulgus Clay Co. 191
*Aurora Pump Co. 202
*Austin Brothers Steel Co. 201

B

*The Babcock & Wilcox Tube Co. 205
*Beaver Pipe Tools, Inc. 235
*Beckman Instruments, Inc. II Cover
Bethlehem Steel Co. 65
W. H. & L. D. Betz 215
*Black, Sivalls & Bryson, Inc. 6, 85
*Blaw-Knox Co. 203, 229
*Born Engineering Co. 170
*Bridgeport Brass Co. 93
The Bristol Co. 35
*Buell Engineering Co. 178

C

Calumet & Hecla Consolidated Copper Co. 42
The Chapman Valve Manufacturing Co. 37
Charlie's Machine Works 203
Chase Brass & Copper Co. 153
*Chemical Construction Corp. 176
Chicago Bridge & Iron Co. I Cover
The Clark Manufacturing Co. 169
Classified Advertising 233
Coast Paint & Lacquer Co. 214
Columbia Steel Co. 39, 192
Conoflow Corp. 182
*Crane Co. 52
*Croll-Reynolds Co. 195

D

Davis Engineering Corp. 227
*Dean Brothers Pumps Inc. 183
Dempster Brothers, Inc. 54
*Dresser Industries, Inc. 162, 165
E. I. du Pont de
Nemours & Co. 68, Insert 200-201

E

*Eastern Industries, Inc. 58
*Elliott Co. 64, 70
Ethyl Corp. Insert 64- 65

F

Filtrol Corp. 56
*Fisher Governor Co. 59
*Flexitallic Gasket Co. 72
*Flint Steel Corp. 228
*Floridin Co. 199
*The Fluor Corp. 160, 231
*Foster Wheeler Corp. Insert 32- 33
The Foxboro Co. 36, 217

G

General Metallizing & Machine Co. 235
*The Girdler Corp. 57
Goodall Rubber Co. 204
A. P. Green Fire Brick Co. 47
*The Griscom-Russell Co. 78- 79
*The Gulf Publishing Co. 210, 233, 235

H

Hammel-Dahl Co. 76
Hardinge Co. 218
A. L. Henderer's Sons 225
Houdry Process Corp. 45
Houghton Laboratories, Inc. 225
Hudson Engineering Corp. 81

I

*Industrial Division,
Minneapolis-Honeywell
Regulator Co. 16-17, 175
Industrial Instrument Corp. 171, 220
*Ingersoll-Rand Co. 8
*International Engineering, Inc. 177
The International Nickel Co. 22

J

*The C. O. Jelliff Mfg. Corp. 230
*Jerguson Gage & Valve Co. 222
*Johns-Manville Co. 186

K

*Keasbey & Mattison Co. 25
*The M. W. Kellogg Co. Insert 96- 97
The C. M. Kemp Mfg. Co. 221
Kerotest Manufacturing Co. 189
Killark Electric Manufacturing Co. 210
Kinney Manufacturing Co. 195
*The Koch Engineering Co. III Cover

L

Layne & Bowler, Inc. 190
Lenape Hydraulic Pressing & Forging Co. 202
Warner Lewis Co. 231
Lukens Steel Co. 44
*The Lummus Co. 86
*The Lunkenheimer Co. 74

M

Manning, Maxwell & Moore, Inc. 32
*The Marley Co. 59
*Mason-Neilan Regulator Co. 2- 3
The Master Electric Co. 90
*Arthur G. McKee & Co. 157
McNamar Boiler & Tank Co. 226
*Minneapolis-Honeywell
Regulator Co. 16-17, 175
*Mixing Equipment Co. 66
Monsanto Chemical Co. 14, 197
Mt. Vernon-Woodberry Mills, Inc. 51
*Murray Iron Works Co. 174

N

*National Airoil Burner Co. 223
*National Carbon Division,
Union Carbide and Carbon Corp. 172
National Tube Co. 39, 192
*W. H. Nicholson & Co. 230
*Nordstrom Valve Division,
Rockwell Manufacturing Co. 28- 29

O

*Oakite Products, Inc. 212
*Orbit Valve Co. 82

P

*Pacific Pumps, Inc. 165
*Palmer Thermometers, Inc. 31
*The Patterson Foundry & Machine Co. 216
*Penberthy Injector Co. 155
*Perco Division,
Phillips Petroleum Co. 164
*Petro-Chem Development Co. 48
*Petroleum Rectifying Co. 63
Phelps Dodge Refining Co. 231
Phillips Petroleum Co. 164
*Pittsburgh Corning Corp. 21
Pittsburgh Lectrodryer Corp. 60
*Posey Iron Works, Inc. 19
The Wm. Powell Co. 62
*The Pressed Steel Co. 46
*J. F. Pritchard & Co. 15
*%Proportioneers, Inc.% 236

R

*R-S Products Corp. 43
Reading-Pratt & Cady Division,
American Chain & Cable Co. 188
*The Refinery Engineering Co. 213
*Republic Steel Corp. 36
*Revere Copper & Brass Inc. 153
The Ric-Wil Co. 222
*The Ridge Tool Co. 181
*Rochester Manufacturing Co. 210
*Rockwell Manufacturing Co. 28- 29
Rockwood Sprinkler Co. 30
*Roots-Connersville Blower Corp. 163

S

Shand & Jurs Co. 33
Shell Development Co. 179
*Sigmund Pumps Limited 180
Sims Pump Valve Co. 219
Solvay Sales Division,
Allied Chemical & Dye Corp. 232
Stancal Asphalt & Bitumuls Co. 231
Standard Oil Co. of California 49
*Stone & Webster Engineering Corp. Opp. 168
*Strafford Engineering Co. 80
*Strong, Carlisle & Hammond Co. 187
*Sun Shipbuilding & Dry Dock Co. 61
Superior Manufacturing Co. 210

T

*Taylor Instrument Companies 41
Tennessee Coal, Iron & Railroad Co. 192
*The Terry Steam Turbine Co. 18
The Timken Roller Bearing Co. 4
Nicolay Titlestad Corp. 211
Turner Halsey Co. 51

U

*Union Asbestos & Rubber Co. 53
*Union Carbide and Carbon Corp. 172
United States Steel Corp. 39, 192
United States Steel Export Co. 39, 192
United States Steel Supply Co. 192
The United States Stoneware Co. 224
Universal Oil Products Co. 12- 13

V

The Vapor Recovery Systems Co. 40
Victor Products Corp. 233
*Henry Vogt Machine Co. 10

W

*Wallace & Tiernan Products, Inc. 167
Walworth Co. 27
Warren Petroleum Corp. 184
Weil Equipment Mfg. Corp. 196
*Western Supply Co. 20
Weston Electrical Instrument Corp. 198
Wheelco Instruments Co. 235
The Whitlock Manufacturing Co. 193
Whiton Machine Co. 203
A. R. Wilfley & Sons, Inc. 209
Thomas C. Wilson, Inc. 223
Wolverine Tube Division,
Calumet & Hecla
Consolidated Copper Co. 42
*Worthington Pump & Machinery Corp. 24, 206
Wyatt Metal & Boiler Works IV Cover

Y

*Yarnall-Waring Co. 34

Z

*Zallea Brothers 166

CONTROL BY AIR POWER

. . . with the Wheelco Pneumatic Capacilog! *For safety*—where electric contactors or motors are a hazard—*for results*—where fixed position changes of fuel or medium are injurious to your product.

Get instant indication, permanent record and control with the smooth-flowing power of air—get the Wheelco Pneumatic Capacilog.

Wheelco instr*umentality* adds safety and product uniformity.

Write for Bulletin C2, Wheelco Instruments Company, 701 W. Harrison Street, Chicago, Illinois.

wheelco *electronic controls*

MEET THE BEAVERETTES!!!

If you have not yet met the Beaverettes, it's high time you were introduced, for these handy little self-contained threaders have been favorites for many years.

The Beaverettes are unique — there is nothing similar to them on the market.

Covering a useful range of pipe sizes from 1/4 to 3/4 inches, the Beaverettes are fully adjustable for cutting standard, oversize or undersize threads of uniform length.

Complete units, having no loose parts of any kind, these tools are accurately centered on the pipe by a smooth-working universal chuck.

Beaver No. 6 is a two-handle non-ratchet tool; the No. 6-R, a standard one-handle ratchet tool, suitable for either bench or confined-area use. Both models are available in either American or British standards, right or left hand, for threading 1/4, 3/8, 1/2 and 3/4 inch pipe. Extra changeable dies are available for 1/8 inch size.

Write Beaver Pipe Tools, Inc., 252-300 Dana Ave., Warren, Ohio, for new "Operating Guide" to help you secure the best possible results from your Portable Pipe & Bolt Machines and Hand Pipe Tools.

BEAVER PIPE TOOLS

Latest data and design methods in fractional distillation

Here is a helpful, basic treatment of fractional distillation principles and practice, thoroughly revised and brought up to date to keep abreast of growth and developments in the petroleum and synthetic chemical industries.

ELEMENTS OF FRACTIONAL DISTILLATION

By ROBINSON and GILLILAND

Massachusetts Institute of Technology

Third Edition. 267 pages, illustrated. $7.00
"Prices subject to change without notice"

This sound, introductory treatment covers the analysis of distillation problems from the standpoint of physical chemistry. It presents qualitative aspects from the standpoint of the Phase Rule and deals with the mathematical analysis of rectification and its application to still design.

Quantitative aspects also are covered, and a number of carefully selected examples are given of the application of principles to standard industrial distillation problems, including those of the petroleum and synthetic chemical industries.

Send orders to

THE GULF PUBLISHING COMPANY

P. O. BOX 2608, HOUSTON, TEXAS

FOR FAST, EXPERT ATTENTION TO:

RESURFACING OF PUMP RODS & SHAFTS

☆

BUILDING-UP OF PACKING AREAS, PISTONS, PISTON RODS & TURBINE SHAFTS

☆

PROTECTIVE METALLIC COATING OVER STEEL VESSELS & STRUCTURES

☆

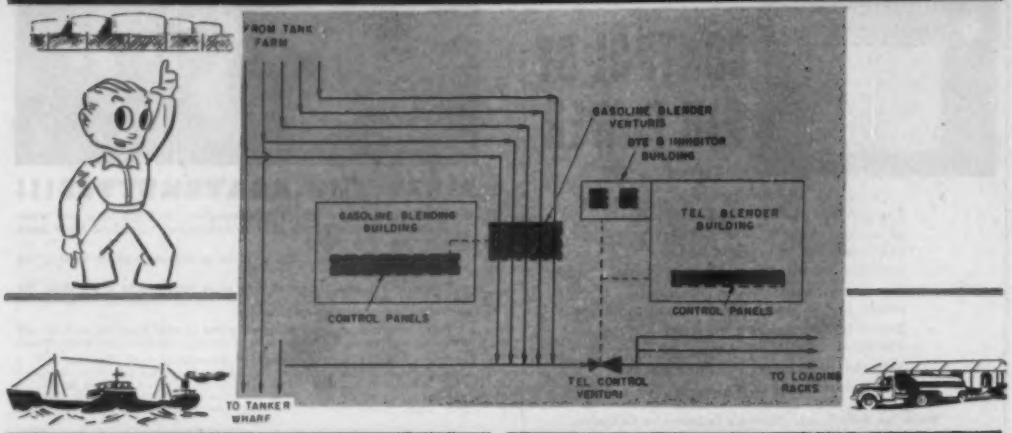
Complete equipment for preparation, spraying, grinding and machining of jobs. Facilities and personnel available anywhere in Gulf Coast-East Texas area.

GENERAL METALLIZING & MACHINE CO.

5815 Armour Drive WI-2295

HOUSTON, TEXAS

Blueprint for continuous blending of gasoline, base stocks, and TEL



%Proportioneers, Inc.% new differential control method continuously blends base stocks and adds inhibitors, dyes and TEL to produce regular and premium gasolines on a direct "tank to tanker" basis *without intermediate storage.*

This exclusive differential control system, field proven in many successful installations, integrates flows of base stocks to produce a product of uniform characteristic regardless of variations in line pressures or flows. The %Proportioneers% method makes the blending process continuous and automatic assuring high accuracy in the blending of components and strict adherence to formula in proportioning even minute quantities of additives. Auxiliary tanks, piping, circulation pumps and mixing equipment are eliminated — with a resultant saving in floor space, power and equipment costs. The %Proportioneers% system offers new speed, flexibility and economy in the production of blends, improving the product and the competitive position of the producer. Ask for recommendations and descriptive literature.

% PROPORTIONEERS, INC. %

Write to %PROPORTIONEERS, INC., 412 Harris Ave., Providence 1, R. I.

Technical service representatives in principal cities of the United States, Canada, Mexico and other foreign countries.

. . . . . WE

30% Guarantee

EXTRA THRUPUT

when your gasoline plant columns are equipped with Koch Kaskade Trays!

THESE REFINERS REPORT EXCEPTIONAL RESULTS

SKELLY
5'-0" diameter, 265# psig. absorber handling 33MM.CF/D and 500 gpm lean oil with 45.5% tray efficiency, basis IC_4. and 73.3% tray efficiency, basis NC_4. Koch Kaskade trays were installed on 26" spacing.

THE TEXAS COMPANY
Obtained increased thruput on 3'-0" diameter. 285# psig. stabilizer to capacities of:

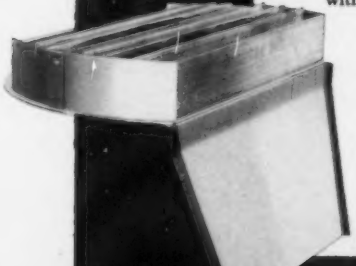
	LIQUID	VAPOR
Volume	450 gpm	0.80 to 2.5 CF/S
Density #/CF	33.1	3.48

Koch Kaskade trays were installed on existing supports—18" to 24" spacing—now operating with excellent results.

WARREN
Obtained increased capacity of a 3'-6" diameter, gasoline plant depropanizer to:

	LIQUID	VAPOR
Volume	471 gpm	7.09 CF/S
Density #/CF	21	2.64

Koch Kaskade replacement of bubble trays, using existing support rings on 24" spacing, has increased the thruput with a bonus of increased separation efficiency.



IT WILL PAY YOU TO INVESTIGATE THE ECONOMY AND OPERATING EFFICIENCY OF KOCH KASKADE FRACTIONATING TRAYS. ***Write us today. No obligation.***

THE KOCH ENGINEERING COMPANY, INC.

DESIGNERS • MANUFACTURERS • BUILDERS
335 WEST LEWIS STREET • WICHITA 2, KANSAS

Eastern and Export
30 Rockefeller Plaza
New York City

Pittsburgh, Pa., Repr.
D. D. Foster Co.
412 Peoples Gas Bldg.

Tulsa, Okla., Repr.
Myers-Bogwell Co.
Wright Bldg.

British Associates
Messrs. A. F. Craig & Co., Ltd.
Paisley, Scotland

CARGO for FRANCE
12' x 72' Deasphalting Tower
A.S.T.M. A-212 Steel 2⅝" thick
HOUSTON · DALLAS · NEW YORK · TULSA